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DIGEST OF REPORT ON ARKANSAS TRAFFIC SURVEY

BY THE DIVISION OF HIGHWAY TRANSPORT, BUREAU OF PUBLIC ROADS

Reported by L. E. PEABODY, Senior Highway Economist

THE Arkansas traffic survey was conducted under a cooperative research agreement between the Bureau of Public Roads and the Arkansas State Highway Commission during the period from April 1934 to June 1935.

The survey was undertaken to obtain essential facts regarding the amount, type, and distribution of traffic, to be used as a basis for planning highway development to serve present and future traffic. Included in the full report,[1] which has been published by the State of Arkansas, is a detailed study of the origin and destination of vehicles; a brief summary of facts regarding the movement of passenger cars and busses; an extended analysis of truck and bus transportation at several locations throughout the State; and a discussion of tourist traffic in Arkansas, including the purposes of visiting Arkansas, the type of accommodations used, the number of persons carried, and the average length of visit.

Owing to the relative traffic importance of the several systems of highways, the following brief description of their character and functions is given:

State highway system.—Those roads legally designated as under the complete jurisdiction of the State highway commission.

Federal-aid system.—Trunk-line highways and highways connecting county seats upon which the expenditure of Federal-aid funds is concentrated, comprising about 7 percent of the total road mileage.[2]

U. S. system.—Numbered and marked highways forming an interconnected system of through routes and distinguished by the United States shield marking. These highways have no special legal status and receive no special funds by reason of being designated U. S. highways.

Forest highway system.—Highways under the jurisdiction of the Forest Service (within or appurtenant to the national forests).

The traffic survey covered over 8,000 miles of road, all of which were on the State highway system. This coverage, amounting to 91 percent of the State highway system, included most U. S. highways and a large portion of Federal-aid and Forest highways as shown in table 1.

TABLE 1.—*Mileage of roads included in the various highway systems, and mileage of each system included in the traffic survey*

Highway system	Total mileage [1]	Miles included in traffic survey	Percentage of total system studied
State	8, 822	8, 043	91
Federal aid	5, 157	5, 063	98
U. S.	2, 740	2, 678	98
Forest	427	320	75

[1] Exclusive of streets in cities of 2,500 or more inhabitants.

[1] The Bureau of Public Roads does not have copies of the full report for general distribution.

[2] Recent emergency legislation has permitted the expenditure of special Federal road funds under certain conditions on roads other than the Federal-aid system.

AVERAGE TRAFFIC OVER ALL HIGHWAYS STUDIED WAS 369 VEHICLES PER DAY

Actual field operations of counting and classifying traffic began on April 23, 1934, and terminated June 1, 1935. In the analysis of the field records a 24-hour day and a 1-year period were the base units to which all data were adjusted.

Data were collected at 266 locations covering the principal State highways. Most of these were at intersecting highways where the field man could record traffic upon three or more roads from one location. The three types of stations operated and their number were:

	Number
Key stations	128
Blanket stations	117
Special stations	21
Total	266

Key stations, frequently referred to as "regular count stations", were situated at the most strategic control points and were operated uniformly at regular intervals during the period of the survey. Each operation covered a 10-hour period on a staggered schedule from 6 a. m. to 4 p. m. and from 10 a. m. to 8 p. m. with splits in the count at 10 a. m. and 4 p. m. This permitted a continuation series of the 10 a. m. to 4 p. m. section through all operations, which were scheduled to provide two counts for each of the seven days of the week during periods of operation. Sufficient night counts from 10 p. m. to 6 a. m. were obtained to adjust all data to a 24-hour day.

Blanket stations were situated on the less important roads and were operated four times during the survey. Data from them have been adjusted to a 24-hour day by correlation with the key stations.

Where the extent of traffic coverage was in doubt or in order to extend the coverage beyond a known point, special stations were set up and operated simultaneously with the nearest controlling key station for a number of days.

The average traffic over all roads surveyed was 369 vehicles per day and traffic ranged from 5,425 vehicles per day on U S 70 between West Memphis, Arkansas and Memphis, Tenn., to zero traffic on several unimproved sections of road in the northeast section of the State. There were three of these sections having no traffic: West of Rector on Ark. 90; south of Tupelo on Ark. 17; and south of Amagon on Ark. 37, where the road was impassable to motor-vehicle traffic during all operations of the traffic stations covering the route.

Figure 1 shows the density of traffic of all vehicles over all highways surveyed. The inner stippled band indicates the 24-hour average daily traffic density and the outer band the maximum traffic.

All recorded data were adjusted, where necessary, from supplemental information to develop daily average traffic densities over a 1-year period representative of normal conditions. Special notations were made of

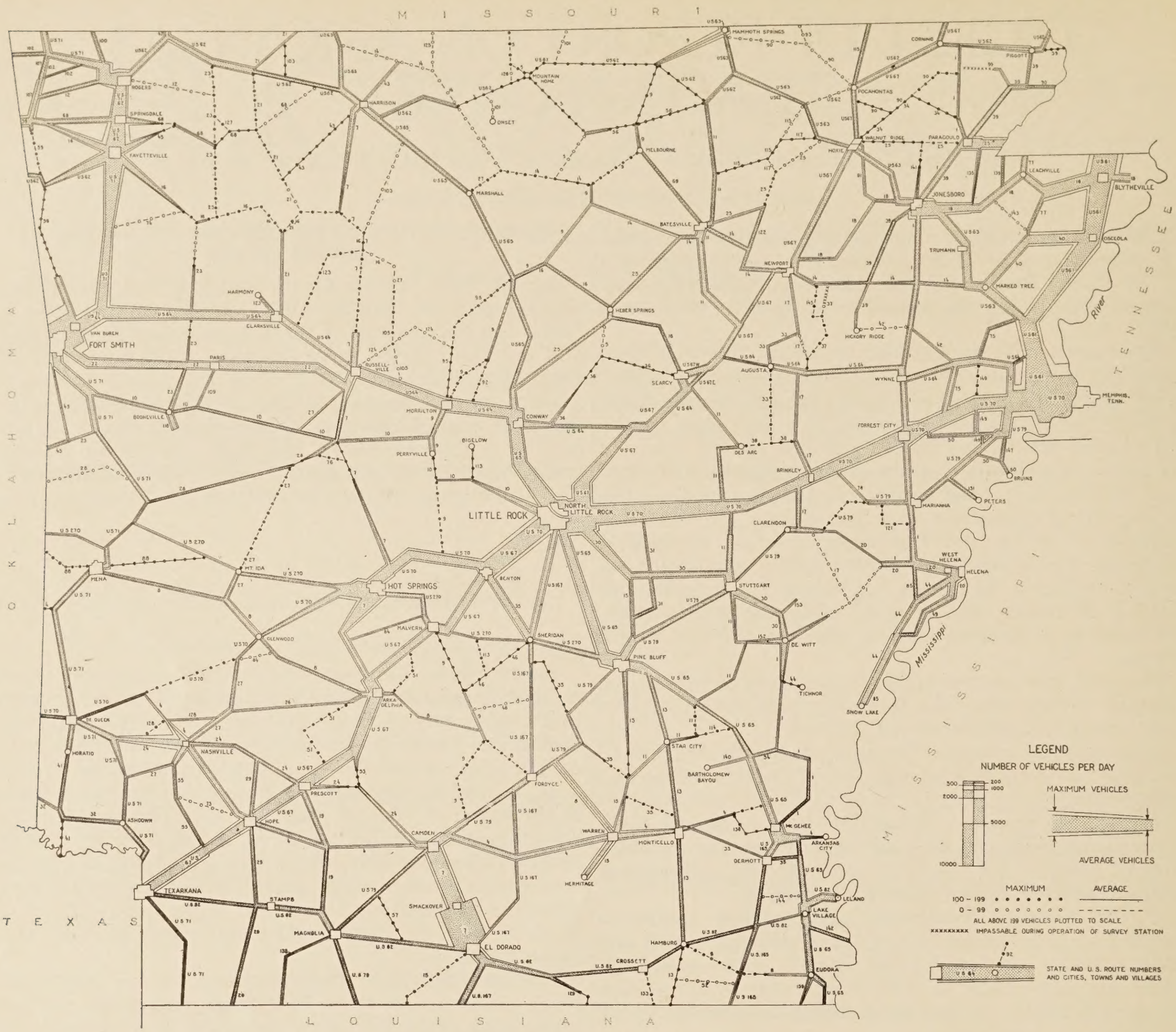

FIGURE 1.—AVERAGE AND MAXIMUM DAILY TRAFFIC DENSITY ON ARKANSAS STATE HIGHWAYS.

trucks and other contractor's equipment engaged on highway construction and abnormally affecting traffic, and proper correction was made for them. Trucks engaged in regular highway maintenance work were considered as normal traffic and included with other trucks. A number of special movements were recorded such as the hauling of lumber, oil, cotton, and peaches and other fruits, all of which occupy a regular place in commercial activities and are a part of normal annual traffic.

Between El Dorado and Camden, there was considerable local traffic created by a large paper mill situated south of Camden and by numerous oil wells in the vicinity of Smackover and El Dorado. Between El Dorado and Smackover, most of the travel was in the nature of shuttle traffic in a restricted but highly important oil-producing area. El Dorado also has a number of important lumber mills.

In the vicinity of Fayetteville, all traffic-flow bands increase in width toward the city. The city of Fayetteville is the State's largest and most important trading center north of Fort Smith, has considerable local development in its environs, and is the home of the State University. To the north of Fayetteville, at Springdale, are located an important winery and canning factory, while farther north there is considerable resort traffic in the region of the Ozark Mountains. All of these factors influence traffic in this section of the State, especially on U S 71.

Particular mention is given routes Ark. 44, 49, and 85 from Helena to Snow Lake and especially in the vicinity of Elaine. Construction work on dikes and levees along the Mississippi River in this area caused abnormal traffic throughout the entire period of the survey. Consequently, for this section of the highway system the traffic was unusually high, and because of the continuing nature of the work no weighting of the data was made.

MAXIMUM TRAFFIC WAS 143 PERCENT OF AVERAGE TRAFFIC

As may be noted by reference to figure 1 there are a number of stub traffic bands some of which end abruptly for no apparent reason, and several unusual ones are explained as follows:

Traffic on Ark. 116 south of Booneville was principally destined to, or returning from, the State Tubercular Sanitorium located 2 miles south of the city. The continuation of Ark. 116 to its junction with U S 71 was unimproved and practically impassable.

Included in the surveyed mileage was 6.6 miles of Ark. 153 north of De Witt, serving a rice-growing district. Traffic over this highway was entirely farm to market. The town of De Witt is the trading and marketing center for a rich rural area and all traffic flow bands in the vicinity increase in width toward the city.

Traffic density on Ark. 15 obtained by the survey station at Warren was extended south to Hermitage. It is likely that traffic diminishes somewhat near Hermitage, but the amount could not be obtained from survey data. The section of Ark. 15 south of Hermitage was not studied.

The portion of Ark. 1 between St. Charles and Indian Bay, a distance of 6 miles, was impassable during a considerable period of the year. Improvement of this section would allow traffic from the area around the confluence of the White and Arkansas Rivers to reach Helena, where water terminal facilities exist.

Trucks were classified at all counting stations by type of equipment as single- or dual-unit loading. The single-unit group includes trucks, tractor trucks, and similar vehicles in which the load carried is one unit, whether supported entirely by the truck or with the aid of accessory wheels. The proportions of single- and dual-unit trucks were as follows:

	Percent
Trucks, including tractor trucks	85. 5
Trucks with trailers or semitrailers (2 or more units)	14. 5
All trucks	100. 0

Single-unit trucks were recorded according to rated capacity and tabulated in three capacity groups—Under 2 tons, from 2 to 5 tons, and 5 tons and over. More than 91 percent of these trucks were under 2 tons capacity, while but 0.1 percent were of 5 tons capacity or over, as shown by the following:

	Percent
Under 2 tons	91. 3
From 2 to 5 tons	8. 6
5 tons and over	. 1
All single-unit trucks	100. 0

Vehicles of foreign registration accounted for 18.7 percent of the traffic recorded at all stations, while the importance of interstate travel is illustrated by the fact that foreign vehicles at 42 border stations amounted to 40.6 percent of the total traffic.

The maximum traffic is the average peak load occurring a number of times during the year. It should not be confused with the absolute maximum traffic peak occurring but once a year. In general, the figures used refer to average maximum traffic conditions occurring on week-end periods during the summer.

For all highways studied, the maximum traffic was 143 percent of the average traffic. For 17 sections of highways, the maximum traffic was over 200 percent of the average traffic. An important characteristic of maximum traffic is its relation to the average daily traffic density; as the traffic density increases, the maximum traffic becomes a smaller percentage of the average traffic. This is illustrated in the following tabulation:

Average daily traffic (all vehicles)	Percentage that maximum traffic is of average traffic	Average daily traffic (all vehicles)	Percentage that maximum traffic is of average traffic
0– 99	180	1,000–1,499	139
100–249	153	1,500–2,499	131
250–499	149	2,500 and over	130
500–999	144		

The utility and earning value of a highway are measured in units of travel—vehicle-miles. This term is defined as the movement of one motor vehicle a distance of 1 mile, and the total travel is the product of the average traffic over a particular section and the mileage of the section.

For the State as a whole there were 2,970,000 vehicle-miles of travel daily, and the average traffic over all roads was 369 vehicles per day. Highways in Mississippi County had the most travel, and included 127 miles of highway with an average traffic of 1,184 vehicles per day. All mileages are from the official map of the State Highway Commission as of January 15, 1935, which shows all State highway mileage by type of surface exclusive of streets in cities of 2,500 or more inhabitants. Traffic count data likewise excluded traffic in cities of 2,500 or more inhabitants.

One-third of the total of 75 counties had nearly 60 percent of the total travel, as may be seen in the following distribution of counties based on vehicle-mile determinations:

	Percentage of total travel
Highest 3 counties	14. 1
Highest 10 counties	32. 9
Highest 25 counties	58. 9
Lowest 10 counties	4. 1

HIGH-TYPE ROADS CARRIED GREATEST TRAFFIC

The traffic data were further segregated and grouped by types ot road surfacing and are summarized in table 2.

TABLE 2.—*Mileage of State highways studied, classified by type of road surfacing and average daily traffic*

Type	Mileage of each type	Average daily traffic
Concrete	1, 023	1, 001
Asphalt	559	780
Retread	410	439
Gravel	5, 167	241
Graded	561	109
Unimproved	323	78
Total	8, 043	369

All of the mileage studied in 15 counties had gravel or lower type of surface. Average traffic in these counties ranged from 84 vehicles per day in Marion County to 347 vehicles per day in Sevier County. In Sevier County the traffic was generally uniform, with the highest section averaging 523 vehicles per day on U S 71 between De Queen and Lockesburg. Compared to the averages for the entire State, this section had traffic equivalent to that for either the retread or asphalt group. Saline County had 8.3 miles of gravel roads carrying an average traffic of 751 vehicles per day, and Mississippi County had 28.1 miles with an average traffic of 520 vehicles per day. These figures are comparable with the State average traffic for retread and asphalt surfacing.

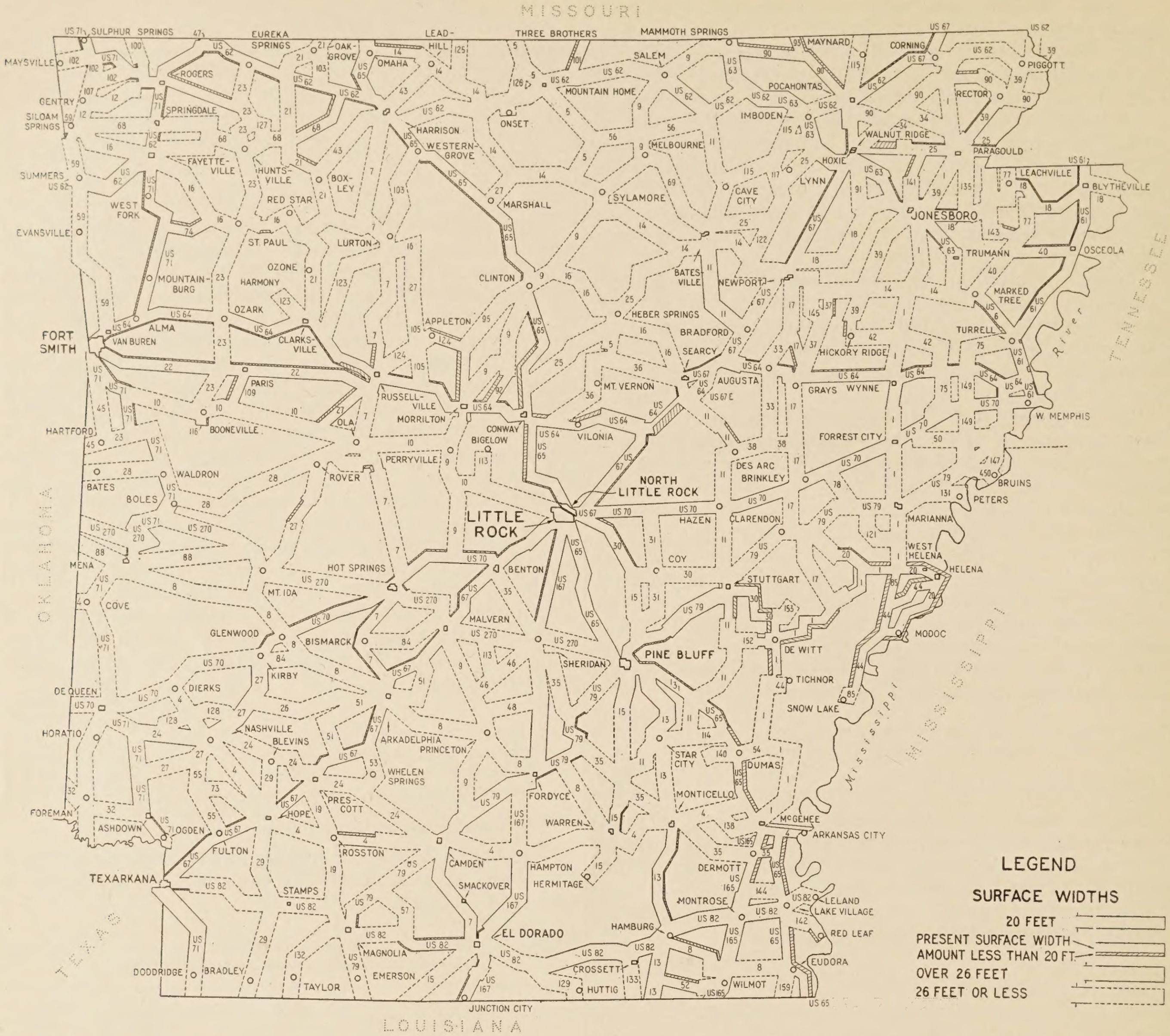

FIGURE 2.—SURFACE WIDTHS OF ARKANSAS STATE HIGHWAYS COVERED BY THE TRAFFIC SURVEY.

Crittenden County showed the highest average traffic for roads with concrete surfaces—2,538 vehicles per day. Woodruff County had the lowest average traffic, or 245 vehicles per day, on its 4.1 miles of concrete road. Columbia, Lawrence, and Lincoln Counties were next in order with average traffic of 327, 356, and 397 vehicles per day, respectively, over an aggregate length of 41.9 miles.

Mississippi County had the highest average traffic for asphalt surfaced highways—1,749 vehicles over 61.6 miles of asphalt surfaced road. Perry County was low with an average traffic of 132 vehicles per day, and Conway County was next with 218 vehicles per day.

Asphalt and concrete surfaced highways of suitable width and thickness are high-type roads, capable of meeting present-day traffic requirements. In Arkansas, these two types were found upon 1,582 miles of surveyed roads, or 20 percent of the total. Average traffic for this mileage amounted to 923 vehicles per day.

Retread surfaces are an intermediate or betterment stage of construction, while gravel roads are usually classified as low type, although their condition and riding qualities may be as good or better than some higher type surfaces.

The traffic survey covered 410 miles of retread surfacing over which traffic ranged from a high of 856 vehicles per day in Pope County to a low of 207 vehicles per day in Pike County. There were no counties that showed traffic on their retread mileage comparable with the average traffic over high-type roads of approximately 920 vehicles per day. But one county, Pope, had traffic on its retread mileage exceeding the State average of 780 vehicles per day for asphalt.

Similarly, comparing the gravel surfacing group with the retread surfacing group, Mississippi and Saline Counties showed traffic on their 36.4 miles of gravel roads in excess of the State average for retread.

A total of 884 miles of graded and unimproved roads was covered by the survey, comprising 11 percent of the total surveyed mileage. Average traffic over these

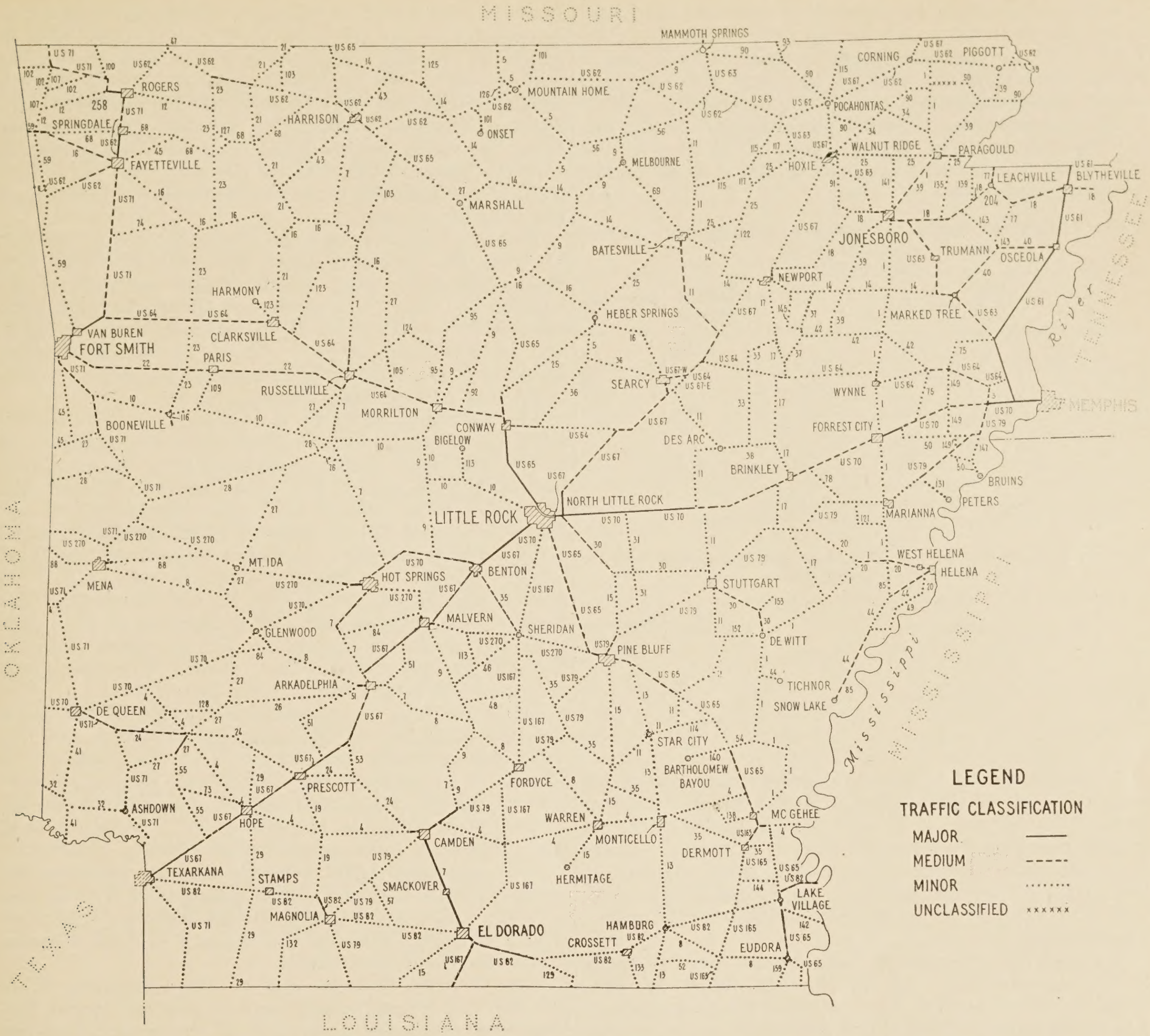

Figure 3.—Classification of State Highways by Volume of Traffic Carried.

roads amounted to 97 vehicles per day. Graded roads are distinguished from unimproved roads principally by drainage conditions, for the surfaces of each are composed of natural or filled earth and consequently are usually dusty in dry weather and slippery in wet weather. Gravel surfacing is the next higher stage of construction, when required by traffic or to make the road an all-weather highway. Three counties showed average traffic on their graded and unimproved roads greater than the average for gravel in the State as a whole. These counties were: Benton, with 10.8 miles of graded road carrying 387 vehicles per day: Garland, with 24.9 miles of graded road carrying 252 vehicles per day; and Phillips, with 7 miles of unimproved road carrying 388 vehicles per day.

Seven different surface widths were reported on Arkansas State highway routes as shown in table 3. Figure 2 shows the present surface width to scale, together with a symbol indicating the additional width necessary to bring the present pavement width up to 20 feet.

EIGHTY PERCENT OF ALL HIGHWAYS STUDIED CARRIED LESS THAN 500 VEHICLES PER DAY

Highways in Arkansas have also been classified in this report according to the amount of traffic carried. These classifications are: Major, medium, and minor.

Figure 3 shows the highways covered in the survey that carried 1,500 or more vehicles per day (major classification); those that carried 500 to 1,499 vehicles per day (medium classification); and those that carried under 500 vehicles per day (minor classification). The surveyed mileage on U. S. and State routes is summarized according to the above classifications in table 4.

There were some sections of Arkansas routes 17, 37, and 90 classified as unimproved that were reported as impassable on the days when traffic was counted at these points. These sections are indicated by a special symbol in figure 3. This figure also shows that a large mileage of Arkansas highways was in the minor classification.

Generally roads of major and medium classifications were main routes crossing Arkansas, more particularly

U S 61, routes from Memphis to Texarkana via Little Rock, and routes from Eudora to Fort Smith via Little Rock. Ark. 7 between Camden and El Dorado was of major classification. This is the only mileage with major classification not on the U. S. system. All of U S 71 between the Missouri Line and Fort Smith was of major or medium classification. U S 61 was the only route in Arkansas that was of major classification for its entire length.

Table 3.—*Surface widths of Arkansas State highways covered by the traffic survey*

Surface width (feet)	Miles of highway	Percentage of total
Over 26	585	7.3
26	[1] 5,143	63.9
20	244	3.0
18	1,343	16.7
16	[2] 354	4.4
14	353	4.4
9 (half width)	21	.3
Total	8,043	100.0

[1] Includes 4.5 miles that may be more or less than 26 feet.
[2] Includes 11 miles reported as impassable during survey counts.

Table 4.—*Classification of Arkansas State highway mileage covered by traffic survey*

Classification	Mileage	Percentage of total
Major	234	2.9
Medium	1,336	16.6
Minor	6,473	80.5
Total	8,043	100.0

There were long routes in Arkansas that had all or practically all of their mileage in the minor classification. This is true of U S 62, which is 344 miles in length including overlaps on other U S routes. There were 294 miles on this route with a traffic density of less than 500 vehicles per day. U S routes 79, 82, 165, 167, and 270 had most of their mileage in the minor classification.

Most of the mileage on State routes was of minor traffic classification. All of the 238 miles on Ark. 9 and 217 miles on Ark. 14 were of minor classification. About 206 miles of the major classification, or 88 percent were located on U. S. routes.

Traffic on a few sections that are reported to be of medium or minor classification may have had a traffic density of a higher classification at one end of the section, but the average traffic for the whole section was such as to place the particular mileage in the lower classification. An example is Ark. 45, which was of medium traffic classification at Fayetteville but of minor classification at the junction with Ark. 68.

ONE-FOURTH OF STATE HIGHWAY MILEAGE CARRIED NEARLY ONE-HALF OF THE TOTAL TRAFFIC

In each highway system there are concentrations of motor-vehicle traffic on certain roads generally referred to as trunkline highways, and as a result of the concentration of traffic a few routes stand out as the principal lanes of travel (fig. 4).

The most heavily traveled route through Arkansas extends from the Mississippi River bridge near Memphis, Tennessee, to Little Rock via U S 70 and thence via U S 67 to Texarkana. From the Mississippi River to Little Rock traffic averaged 1,725 vehicles per day, of which 39 percent was foreign. From Little Rock to Texarkana traffic averaged 1,137 vehicles per day, of which 36 percent was foreign. On this section at Benton there was a considerable change in density owing to the use of U S 70 by traffic going to Hot Springs National Park. The greatest traffic density along the route was recorded between West Memphis and Memphis—5,425 vehicles per day; and the lowest traffic density on this route was southwest of Malvern—752 vehicles per day.

The most heavily traveled intrastate route was U S 61 from the Missouri State line near Blytheville to West Memphis, over which traffic averaged 1,949 vehicles per day. The section on this route having the least traffic, north from Blytheville to the State line, had 1,452 vehicles per day. This is an especially heavy trucking route, averaging 419 trucks per day or nearly twice that of any other through route.

The principal highway connecting the two largest cities in Arkansas—Little Rock with a population of 81,679 and Fort Smith with 31,429—is the combination of U S 64 and U S 65 via Conway, Russellville, and Clarksville. All of this route has high-type surfacing, and over its 151 miles of length traffic averaged 1,106 vehicles per day. Between Russellville and Fort Smith, vehicles can use an alternate route—Ark. 22 with a portion of Ark. 7 and 27 via Dardanelle and Paris. This parallel highway is likewise of high-type surfacing with the exception of 3.3 miles between Russellville and Dardanelle. Traffic over this alternate route averaged 805 vehicles per day.

Little Rock is the commercial center of the State and the majority of the principal highways connect with this centrally located city like the spokes of a wheel. Also between Fort Smith and Rogers are concentrations of population which, combined with the interstate importance of route U S 71, gave roads in the northwest area considerable traffic. Traffic on U S 71 averaged 1,109 vehicles per day between the Missouri State line and Alma (junction of U S 71 and U S 64). The total traffic on this highway was practically equal to that on U S 64 and U S 65 between Little Rock and Fort Smith.

U S 70 from Benton west to the Oklahoma State line showed unusual variations in average traffic flow that were especially noticeable on the section between Benton and Hot Springs. This section carried an average traffic of 985 vehicles per day, while west of Hot Springs to the State line the traffic was 281 vehicles per day. The city of Hot Springs and Hot Springs National Park receive most of their traffic from the north and east.

The length of all routes illustrated in figure 4 totals 2,019 miles, or 25.1 percent of all roads covered by this survey. Their classification by traffic density groups is shown in table 5.

Table 5.—*Classification of principal through routes shown in figure 2 by density of traffic*

Vehicles per day	Selected through routes	Percentage of total
	Miles	
Under 250	190	9.4
250–499	732	36.3
500–1,499	897	44.4
Over 1,500	200	9.9
Total	2,019	100.0

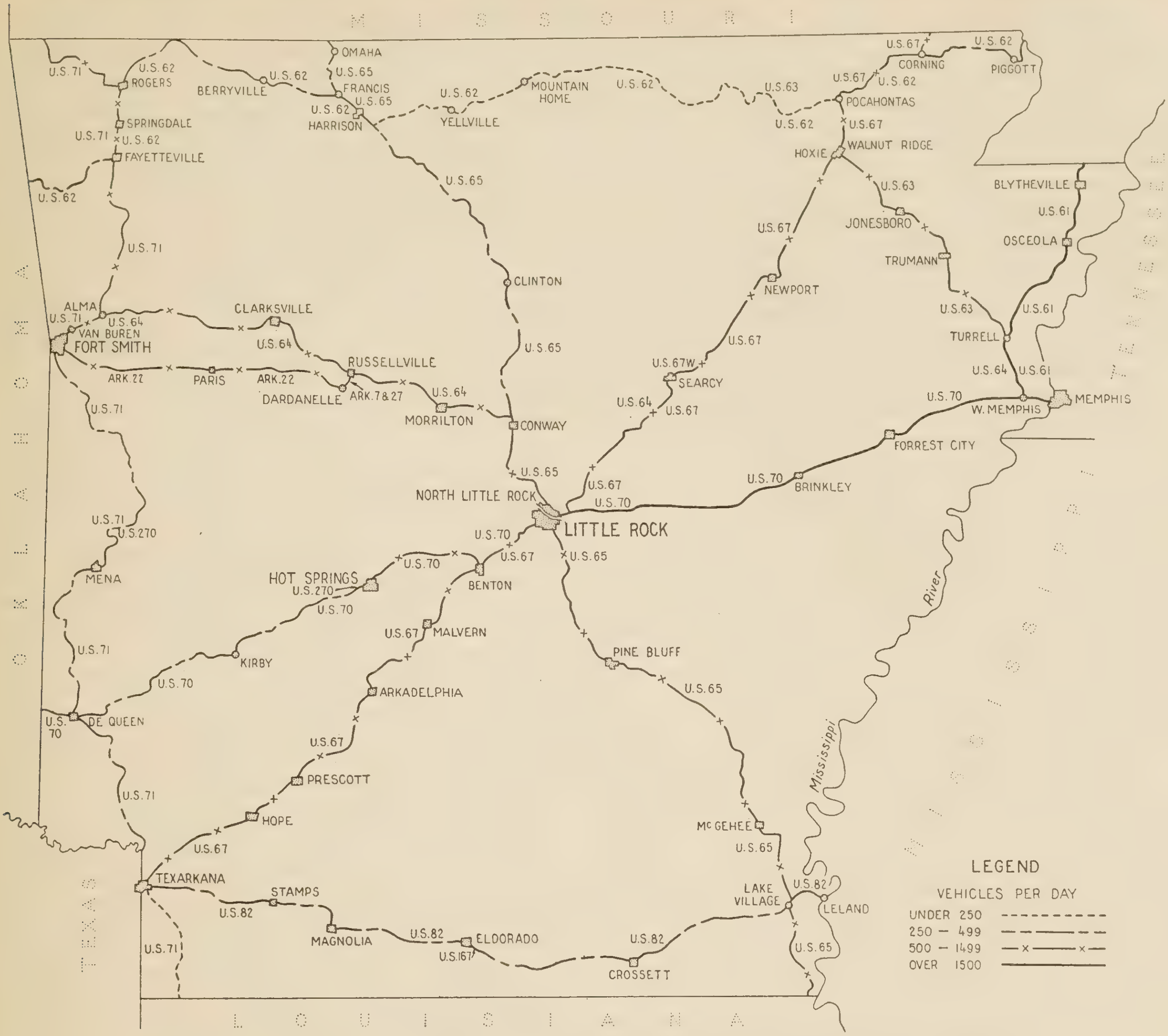

Figure 4.—Principal Through Routes Carrying the Largest Volumes of Traffic.

From this table it will be seen that approximately 10 percent of the through-route mileage carried a traffic in excess of 1,500 vehicles per day (major classification), and 46 percent carried a traffic of 500 or less vehicles per day (minor classification).

Travel upon the highways shown in figure 4 and listed in table 5 amounted to 1,450,000 vehicle-miles per day, or nearly 49 percent of that upon all roads covered by this survey. Thus, one-fourth of the State highway mileage was carrying about one-half of the total traffic.

Detailed data for a representative sample of truck, bus, and passenger-car traffic were recorded at 25 stations in various parts of the State. These stations were numbered consecutively from 1 to 25.

SPECIAL STUDIES CONDUCTED AT 25 STATIONS

These 25 stations were located on the main thoroughfares of the State and in the vicinity of Little Rock and other principal cities. Stations 1, 3, 8, 10, and 19 were located on U S 67 which traverses the State from northeast to southwest. Stations 2 and 4 were on U S 63 and 64, respectively. Stations 5 and 7 were on U S 70 between Memphis, Tenn., and Little Rock. Station 6 was on U S 79 between Memphis and Pine Bluff. Station 23 was near Fort Smith on Ark. 22, which converges at Russellville with U S 64 and thence joins U S 65 north of Conway. Stations 9, 12, 13, and 14 were on U S 65, which crosses the State from northwest to southeast, and stations 11, 15, and 16 were on U S 167 which runs south from Little Rock to El Dorado and the Louisiana border. Station 17 was between El Dorado and Texarkana on U S 82, the southernmost east-west highway of the State. Stations 25, 24, 22, 21, 20, and 18 were on U S 71, the principal north-south highway in the western part of the State. In the tables that show figures for individual stations, the stations are listed in the order outlined above.

The information relating to truck, bus, and passenger-car traffic recorded at these 25 stations included the State of registration of each vehicle; its origin and destination on the current trip; the situs of ownership, whether farm or city, the latter class being subdivided into private and company ownership; and the trip classification, whether State, interstate, or trans-State. Information was also obtained regarding the operation of trucks and busses, whether privately operated or operated as contract haulers or common carriers; and the extent of contact of trucks and busses with railroad service, that is, whether they stopped or started at a railroad station. The nature of the load carried, rated capacity, and gross axle and trailer loads of trucks, and the number of passengers carried by busses at the time of questioning, were also recorded.

The difference between the totals in the individual tables results from the fact that every item of information was not obtained for all vehicles. Since the size of the samples used in the tables varies slightly, actual numbers should be used only in connection with those in the analysis in which they occur. Percentages, however, which represent general relations, may be used without this restriction.

Certain terms that are used in the following tables are defined as follows:

Trip classifications: *State*—a trip on which the vehicle did not cross the boundaries of Arkansas; *interstate*—a trip on which the vehicle had one terminus in Arkansas and crossed the boundaries of the State en route. In some cases both the origin and destination were within the State. *Trans-State*—a trip on which the vehicle passed through Arkansas en route between points in other States.

Classes of operation: *Private operator*—a vehicle operated by its owner or his employee in the pursuit of the owner's private business, as distinguished from the two classes of commercial vehicles engaged in hauling for others for hire; *contract hauler*—a vehicle that makes special trips when and where desired, at rates agreed upon by the contracting parties; *common carrier*—a vehicle that followed established routes between fixed points, and operated on a regular schedule at standard published rates.

Capacities of trucks—Manufacturers' rated capacities are sometimes combined into the following groups: *Light*—1½ tons and under; *medium*—between 1½ and 3 tons; *heavy*—3 tons and over.

Nature of load carried: *Manufactured products*—wholesale deliveries, automobile parts, newspapers, or any other class of manufactured commodities; *agricultural products*—all unprocessed products of agriculture, including milk, livestock, etc.; *mineral products* — coal, marble, oil, gasoline, etc.; *forest products* — lumber, trees, shrubs, etc.; *household goods* — furniture in moving vans, etc., excluding new furniture which belongs with manufactured products; *highway materials*—State highway trucks, construction materials, etc.

Definitions of vehicle-units: *Trailer*—any trailer or semitrailer without distinction as to size or type of unit; *single-unit trucks*—trucks of which both engine and body were supported by a single chassis; *truck-trailer combinations*—a motor unit to which full or semitrailer units were attached.

Daily motor traffic at these 25 stations between April 1934 and June 1935 averaged 26,848 vehicles per day, of which 80.2 percent were passenger cars, 18.7 percent trucks, and 1.1 percent busses. An average of only about one truck per thousand was recorded as making contact with railroad service, the range among individual stations being from one to five trucks per thousand. An average of 29 busses per hundred recorded made contact with railroad service by having one or the other (or both) of their terminals at a railroad station. Busses making such contact varied from 2 to 75 percent of those recorded at individual stations.

Approximately three out of four vehicles of all kinds carried Arkansas registration plates. A greater percentage of trucks and busses than of passenger cars carried such tags. A little less than two out of three vehicles of all types were owned by individuals living in cities, one out of four by city companies, and one out of nine by farmers. Six out of 10 vehicles were engaged in State traffic, almost 3 out of 10 in interstate traffic, and about 1 out of 11 in trans-State traffic.

CLASSIFICATION OF LOADS CARRIED BY TRUCKS DISCUSSED

The classification of single-unit trucks and of truck-trailer combinations according to whether they were loaded or empty at the time of questioning, and according to the designated type of load carried, is presented in table 6.

Sixty-one percent of all trucks recorded at 25 stations were loaded, and 39 percent were empty. Manufactured products comprised the loads of more than one-half of the loaded trucks. One out of 5 of the loaded trucks carried agricultural products and 1 out of 10 carried passengers. Next in importance as truck loads were mineral and forest products, followed by household goods, highway materials, and retail delivery in the order named.

Table 6.—*Classification of single-unit trucks and trucks with trailers recorded at 25 stations, by nature of load carried*

Nature of load carried	Single-unit trucks		Truck-trailer combinations		All trucks		Percentage of combinations with only one trailer
	Number	Percentage of grand total	Number	Percentage of grand total	Number	Percentage of grand total	
Commercial commodities:							
Manufactured products	8,180	29.1	2,243	39.7	10,423	30.8	98.8
Agricultural products	3,393	12.1	720	12.8	4,113	12.2	99.4
Mineral products, oil	1,264	4.5	82	1.5	1,346	4.0	100.0
Forest products	724	2.6	465	8.2	1,189	3.5	100.0
Retail delivery	90	.3			90	.3	
Total	13,651	48.6	3,510	62.2	17,161	50.8	99.1
Other types of load:							
Passengers	1,947	6.9	57	1.0	2,004	5.9	100.0
Household goods	626	2.2	76	1.3	702	2.1	100.0
Highway materials	560	2.0	32	.6	592	1.8	100.0
Total	3,133	11.1	165	2.9	3,298	9.8	100.0
All types of load	16,784	59.7	3,675	65.1	20,459	60.6	99.1
Empty	11,351	40.3	1,971	34.9	13,322	39.4	99.4
Grand total	28,135	100.0	5,646	100.0	33,781	100.0	99.2

A greater percentage of truck-trailer combinations than of single-unit trucks carried manufactured products, although the actual number of single-unit trucks carrying this class of commodities was almost four times as great as that of truck-trailer combinations. About the same percentage of each type of trucks carried agricultural products. A greater percentage of single-unit trucks carried mineral products, such as coal, marble, oil, and gasoline, while a much greater percentage of trucks with trailers carried forest products. Only single-unit trucks were recorded as making retail delivery, and there were comparatively few of these. Since the stations at which these traffic samples were taken were usually in the outskirts or entirely outside of commercial centers, the low percentage of retail delivery trucks indicates the infrequency of this type of transportation in outlying areas of Arkansas.

These five groups of products have been combined into a major group, called commercial commodities, as distinguished from other types of loads, such as passengers, used household goods, and State highway trucks. Almost 49 percent of all single-unit trucks and more than 62 percent of trucks with trailers were carrying commercial commodities. The corresponding percentages for all other types of load were about 11 and 3 percent, respectively.

The frequency distribution of busses carrying various numbers of passengers is given in table 7. The average number of passengers carried by busses in each frequency group is also shown.

TABLE 7.—*Classification of busses recorded at 25 stations, by number of passengers carried*

Number of passengers	Number of busses	Percentage of total	Cumulative percentage	Average number of passengers
None	196	8.7	8.7	0.0
1 to 5	564	25.0	33.7	3.0
6 to 10	494	21.9	55.6	7.8
11 to 15	325	14.4	70.0	13.0
16 to 20	252	11.2	81.2	17.6
21 to 25	166	7.3	88.5	22.8
26 to 30	124	5.5	94.0	28.1
31 to 35	61	2.7	96.7	33.0
36 to 40	35	1.5	98.2	38.3
41 to 45	16	.7	98.9	44.1
46 to 50	18	.8	99.7	49.1
More than 50	8	.3	100.0	59.4
Total	2,259	100.0		11.9

Among busses that operated exclusively within the State, there were about three contract-hauler busses, including hired school busses, chartered busses, and the like to every seven common-carrier busses. Comparatively few contract-hauler busses were found in interstate or trans-State traffic, more than 9 out of 10 of these being common carriers.

More than half of the privately owned busses were contract haulers, but only about 4 percent of company owned busses were engaged in this class of operation. The principal business of company owned busses was that of serving the public as common carriers.

EIGHTY-NINE PERCENT OF ALL BUSSES CARRIED 25 PASSENGERS OR LESS

From the average daily density of truck traffic and the average gross weight of trucks recorded at each of the 25 stations, the estimated total gross weight of daily truck traffic, including both single-unit trucks and truck-trailer combinations, have been derived. These data are presented in table 8.

The average gross weight of all single-unit trucks recorded at the 25 stations was 6,270 pounds. The gross weight of loaded single-unit trucks was 7,390 pounds, and that of empty trucks of this type was 4,550 pounds. The corresponding average gross weights of truck-trailer combinations were 15,040 pounds, 18,320 pounds, and 8,920 pounds, respectively. Thus, loaded trailer combinations weighed about two and one-half times as much as loaded single-unit trucks, and empty trailer combinations about twice as

TABLE 8.—*Estimated total gross weight of daily truck traffic recorded at 25 stations*

Station number	Location of station	Average daily truck traffic	Average gross weight per truck	Estimated daily gross weight: Weight	Estimated daily gross weight: Percentage of total
		Number	*Pounds*	*Pounds*	
1	U S 67 and 62 at Corning	130	6,180	803,400	2.2
3	U S 67 and Ark. 14 west of Newport	102	6,680	681,360	1.8
8	U S 67 northeast of North Little Rock	228	6,390	1,456,920	4.0
10	U S 67 and 70 southwest of Little Rock	320	7,280	2,329,600	6.3
19	U S 67 northeast of Fulton	103	7,180	739,540	2.0
2	U S 63 and Ark. 9 at Mammoth Springs	145	5,330	772,850	2.1
4	U S 64 west of Augusta	38	8,720	331,360	.9
5	U S 70 east of West Memphis	988	8,750	8,645,000	23.4
7	U S 70 at De Valls Bluff	130	11,140	1,448,200	3.9
6	U S 79 at Roe	32	8,910	285,120	.8
23	Ark. 22 east of Ft. Smith	196	7,340	1,438,640	3.9
9	U S 65 and 64 north of Conway	398	7,670	3,052,660	8.3
12	U S 65 south of Little Rock	120	7,920	950,400	2.6
13	U S 65 and Ark. 13 east of Pine Bluff	189	7,190	1,358,910	3.7
14	U S 65 and 165 southeast of McGehee	244	5,700	1,390,800	3.8
11	U S 167 south of Little Rock	106	6,430	681,580	1.8
15	U S 167 northeast of El Dorado	28	8,280	231,840	.6
16	U S 167 and 82 southeast of El Dorado	170	5,930	1,008,100	2.7
17	U S 82 at Garland City	41	8,200	336,200	.9
25	U S 71 and 62 west of Rogers	471	6,570	3,094,470	8.4
24	U S 71 and 64 at Alma	435	7,160	3,114,600	8.5
22	U S 71 southeast of Ft. Smith	180	6,580	1,184,400	3.2
21	U S 71 and 270 northeast of Mena	63	7,040	443,520	1.2
20	U S 71 south of Ogden	100	7,140	714,000	1.9
18	U S 71 southeast of Texarkana	65	6,410	416,650	1.1
	Average or total	5,022	7,350	36,910,120	100.0

much as empty single-unit trucks. The average net load of single-unit trucks was 2,840 pounds, and that of trailer combinations was 9,400 pounds, the latter being more than three times as great as the former.

The average gross weights of trucks, according to rated capacity groups were as follows: Loaded single-unit trucks—light, 6,830 pounds; medium, 13,040 pounds; and heavy, 19,880 pounds: Empty single-unit trucks—light, 4,310 pounds; medium, 8,660 pounds; and heavy, 15,740 pounds. These figures indicate that an average net load of 2,520 pounds was carried by light trucks of this type, 4,380 pounds by medium-size trucks, and 4,140 pounds by heavy trucks, the heaviest average net load being carried by medium-size trucks.

DATA ON AXLE LOADS AND TOTAL GROSS LOADS OF TRUCKS PRESENTED

The total gross weights of single-unit trucks and truck-trailer combinations ranged as follows: From 1,000 to 20,000 pounds for empty single-unit trucks, with a median between 4,000 and 5,000 pounds; from 1,000 to 42,000 pounds for empty truck-trailer combinations, with a median between 8,000 and 9,000 pounds; from 1,000 to 33,000 pounds for loaded single-unit trucks, with a median between 6,000 and 7,000 pounds; and from 2,000 to 67,000 pounds for loaded truck-trailer combinations, with a median between 18,000 and 19,000 pounds. The median group in each series represents the point so chosen that half the number in the series were above and half below it. In each group the presence of a few very heavy trucks was balanced by a larger number in the lighter-weight groups. The greatest average gross weight of loaded single-unit trucks was found among those carrying forest products, and the average gross weight of those loaded with mineral products was almost as great. Among truck-trailer combinations, however, trucks having the greatest average gross weights carried manufactured or agricultural products.

Figure 5.—Average Gross Axle Loads of Trucks Recorded at 25 Stations by Various Classifications.

Average gross axle and total loads of trucks according to trip, operation, and ownership classifications, rated capacity, and nature of load carried, are presented in tables 9 to 12 inclusive. The principal items are also shown graphically in figure 5.

Table 9.—*Number and average axle loads of trucks recorded at 25 stations, by various classifications*

Classification	Number of trucks	Average gross loads [1]				
		Front axle		Rear axle		
		Weight	Percentage of total weight	Weight	Percentage of total weight	Total weight
Trip classification:		*Pounds*		*Pounds*		*Pounds*
State	23, 584	1, 880	32. 4	3, 930	67. 6	5, 810
Interstate	9, 107	2, 070	29. 0	5, 060	71. 0	7, 130
Trans-State	1, 210	2, 310	26. 9	6, 290	73. 1	8, 600
Total	33, 901	1, 950	31. 1	4, 320	68. 9	6, 270
Class of operation:						
Private operator	28, 763	1, 870	32. 5	3, 890	67. 5	5, 760
Contract hauler	3, 460	2, 260	26. 2	6, 360	73. 8	8, 620
Common carrier	1, 568	2, 740	26. 3	7, 680	73. 7	10, 420
Total	33, 791	1, 950	31. 1	4, 320	68. 9	6, 270
Situs of ownership:						
Farm	5, 892	1, 510	35. 4	2, 750	64. 6	4, 260
City—Private	12, 628	1, 830	31. 1	4, 050	68. 9	5, 880
City—Company	15, 313	2, 210	30. 1	5, 140	69. 9	7, 350
Total	33, 833	1, 950	31. 1	4, 320	68. 9	6, 270
Rated capacity:						
Light	31, 383	1, 820	31. 3	4, 000	68. 7	5, 820
Medium	2, 395	3, 460	29. 3	8, 340	70. 7	11, 800
Heavy	84	5, 920	32. 1	12, 510	67. 9	18, 430
Total	33, 862	1, 950	31. 1	4, 320	68. 9	6, 270
Nature of load carried:						
Commercial	17, 161	2, 080	26. 7	5, 690	73. 3	7, 770
Other types of load	3, 298	1, 770	33. 1	3, 580	66. 9	5, 350
All types of load	20, 459	2, 030	27. 5	5, 360	72. 5	7, 390
Empty	13, 322	1, 820	40. 0	2, 730	60. 0	4, 550
Total	33, 781	1, 950	31. 1	4, 320	68. 9	6, 270

[1] Represents gross weights of motor trucks, excluding trailers.

Table 10.—*Number and average axle loads of trucks recorded at 25 stations on Arkansas highways, by nature of load carried*

Nature of load carried	Number of trucks	Average gross loads [1]				
		Front axle		Rear axle		
		Weight	Percentage of total load	Weight	Percentage of total load	Total weight
Commercial commodities:		*Pounds*		*Pounds*		*Pounds*
Manufactured products	10, 423	2, 130	28. 1	5, 440	71. 9	7, 570
Agricultural products	4, 113	1, 960	25. 0	5, 880	75. 0	7, 840
Mineral products, oil	1, 346	2, 260	26. 8	6, 160	73. 2	8, 420
Forest products	1, 189	1, 930	21. 7	6, 970	78. 3	8, 900
Retail delivery	90	1, 410	38. 2	2, 280	61. 8	3, 690
Total	17, 161	2, 080	26. 7	5, 690	73. 3	7, 770
Other types of load:						
Passengers	2, 004	1, 590	36. 8	2, 740	63. 2	4, 330
Household goods	702	1, 810	28. 1	4, 630	71. 9	6, 440
Highway materials	592	2, 330	30. 9	5, 200	69. 1	7, 530
Total	3, 298	1, 770	33. 1	3, 580	66. 9	5, 350
All types of load	20, 459	2, 030	27. 5	5, 360	72. 5	7, 390
Empty	13, 322	1, 820	40. 0	2, 730	60. 0	4, 550
Grand total	33, 781	1, 950	31. 1	4, 320	68. 9	6, 270

[1] Represents gross weights of motor trucks, excluding trailers.

Table 11.—*Number and average axle loads of empty trucks recorded at 25 stations, by rated capacity*

Rated capacity	Number of trucks	Average gross loads [1]				
		Front axle		Rear axle		
		Weight	Percentage of total load	Weight	Percentage of total load	Total weight
		Pounds		*Pounds*		*Pounds*
½ ton [2]	4, 757	1, 390	47. 3	1, 550	52. 7	2, 940
1 ton [3]	644	1, 440	41. 0	2, 070	59. 0	3, 510
1½ tons	7, 217	1, 990	37. 6	3. 300	62. 4	5, 290
2 tons	444	2, 860	37. 0	4, 860	63. 0	7, 720
2½ tons	41	3, 420	38. 6	5, 430	61. 4	8, 850
3 tons	131	3, 870	37. 5	6, 450	62. 5	10, 320
3½ tons	52	4, 760	40. 5	6, 980	59. 5	11, 740
4 tons	7	4, 770	36. 5	8, 300	63. 5	13, 070
5 tons	26	5, 840	37. 1	9, 900	62. 9	15, 740
Capacity groups: [4]						
Light	12, 618	1, 740	40. 4	2, 570	59. 6	4, 310
Medium	675	3, 260	37. 6	5, 400	62. 4	8, 660
Heavy	26	5, 840	37. 1	9, 900	62. 9	15, 740
All capacities	13, 319	1, 820	40. 0	2, 730	60. 0	4, 550

[1] Represents gross weights of motor trucks, excluding trailers.
[2] Includes two ¼-ton trucks.
[3] Includes two ¾-ton trucks.
[4] Light, 1½ tons and under; medium, between 1½ and 5 tons; heavy, 5 tons and over.

The average gross total weight of all trucks was 6,270 pounds, or a little more than 3 tons. The average gross weight on the front axles of all trucks was 1,950 pounds, and that on the rear axles was 4,320 pounds, representing 31.1 percent and 68.9 percent of the total, respectively.

The percentage of average gross weight carried by the front axle of trucks, grouped according to rated capacity, was greatest for heavy trucks and least for those of medium capacity. The corresponding percentage for trucks loaded with commercial commodities was smaller than that for those carrying other types of load. The percentages of the average total gross loads carried by front and rear axles were 27.5 and 72.5 percent for loaded and 40 and 60 percent for empty trucks.

TABLE 12.—*Number and average axle loads of loaded trucks recorded at 25 stations, by rated capacity*

Rated capacity	Number of trucks	Average gross loads [1]				
		Front axle		Rear axle		Total weight
		Weight	Percentage of total load	Weight	Percentage of total load	
		Pounds		*Pounds*		*Pounds*
½ ton [2]	5,660	1,390	39.4	2,140	60.6	3,530
1 ton [3]	1,079	1,500	30.0	3,500	70.0	5,000
1½ tons	12,026	2,150	25.1	6,400	74.9	8,550
2 tons [4]	1,174	3,160	26.3	8,870	73.7	12,030
2½ tons [5]	174	3,920	29.2	9,510	70.8	13,430
3 tons	271	4,290	27.4	11,370	72.6	15,660
3½ tons	77	5,710	32.6	11,780	67.4	17,490
4 tons	24	4,260	27.7	11,120	72.3	15,380
5 tons [6]	58	6,010	30.2	13,870	69.8	19,880
Capacity groups: [7]						
Light	18,765	1,880	27.5	4,950	72.5	6,830
Medium	1,720	3,550	27.2	9,490	72.8	13,040
Heavy	58	6,010	30.2	13,870	69.8	19,880
All capacities	20,543	2,030	27.5	5,360	72.5	7,390

[1] Represents gross weights of motor trucks, excluding trailers.
[2] Includes one ¼-ton truck.
[3] Includes six ¾-ton trucks.
[4] Includes one 1¾-ton truck.
[5] Includes one 2¼-ton truck.
[6] Includes one 7½-ton truck.
[7] Light, 1½ tons and under; medium, between 1½ and 5 tons; heavy, 5 tons and over.

LIGHT TRUCKS HAD GREATEST TENDENCY TO EXCEED RATED CAPACITY

The greatest average gross weight of trucks classified according to the nature of load carried was found among those which carried forest products, mineral products, such as coal, oil, marble and similar products, and agricultural products. Trucks carrying these three groups of commodities also showed a smaller percentage of the total weight carried by the front axle than that of other groups, indicating that net loads of these commodities were relatively heavier, and that the loaded weight was concentrated principally on the rear axle. Retail delivery trucks and trucks carrying passengers showed a relatively greater proportion of the total gross load carried by the front axle, and trucks carrying manufactured products, including wholesale delivery trucks, as well as household goods and highway materials, were in an intermediate position.

Average gross weights of trucks, classified according to rated capacity, are shown in tables 11 and 12. For empty trucks, both total and individual axle weights of these groups showed an approximately straight-line increase which varied directly with the increasing rated capacity. The few minor irregularities which appear in these series were caused in part by the small number of trucks in the samples for certain groups. But still another factor must be considered, that is, the inclusion in these samples of trucks of any and all makes, some of which were of light and some of extremely heavy construction, with many gradations between. The majority of trucks in the lowest rated capacity groups were of the lighter makes, and those in the 1½-ton capacity group, also, were principally of this type, while most, if not all, of the trucks of 5-tons capacity or over were of the more heavily built makes. In the intervening group, however, in addition to trucks of moderately heavy construction, there were some of the heavier trucks of lighter makes, and a scattering of the lighter trucks of heavy makes, thus producing a composite group which does not conform to any of the types of which it is partly composed.

In the case of loaded trucks there are even more factors affecting the composition of the sample. Here, in addition to the differences between the vehicles themselves, the variation in the nature and weight of loads carried is also involved. Despite these divergent elements, the average total and axle weights of trucks, arranged in increasing order by rated capacity, show a comparatively regular increase, with the exception of the 4-ton capacity group, at which a marked break occurs in each series. This may be ascribed to the fact that the number of trucks in this capacity group is not sufficiently large to give a true average. The inadequacy of this group is shown in the frequency distribution.

Although the net weight of loads carried by individual trucks was not obtained in connection with this survey, it is possible to arrive at an approximate average net weight of loads by subtracting the weight of empty trucks from that of loaded trucks of corresponding rated capacity groups. This method has been followed in obtaining the figures presented in the third column of table 13.

The average net weight of loads increased with increase in rated capacity, but at a lesser rate than the capacity itself, up to the 4- and 5-ton groups, for which the computed average net loads were smaller than those for the 1½- and 2-ton groups, respectively. The greatest average net load was carried by 3- and 3½-ton trucks. Trucks of light rated capacity carried relatively heavier net loads, and heavy trucks relatively lighter net loads, in comparison with their capacity. The average net load of trucks of all capacities was about 1.1 times the average rated capacity.

TABLE 13.—*Average gross and net loads of trucks of each rated capacity recorded at 25 stations, and ratio to rated capacity*

Rated capacity	Average gross weight [1]		Average net weight [1]	Ratio of rated capacity to—	
	Loaded trucks	Empty trucks		Average loaded weight	Average net weight
	Pounds	*Pounds*	*Pounds*		
½ ton	3,530	2,940	590	1:3.5	1:0.6
1 ton	5,000	3,510	1,490	1:2.5	1:0.8
1½ tons	8,550	5,290	3,260	1:2.9	1:1.1
2 tons	12,030	7,720	4,310	1:3.0	1:1.1
2½ tons	13,430	8,850	4,580	1:2.6	1:0.9
3 tons	15,660	10,320	5,340	1:2.6	1:0.9
3½ tons	17,490	11,740	5,750	1:2.5	1:0.8
4 tons	15,380	13,070	2,310	1:1.9	1:0.3
5 tons	19,880	15,740	4,140	1:2.0	1:0.4
Capacity groups: [2]					
Light [3]	6,830	4,310	2,520	1:3.0	1:1.1
Medium [4]	13,040	8,660	4,380	1:2.9	1:1.0
Heavy [5]	19,880	15,740	4,140	1:2.0	1:0.4
All capacities [6]	7,390	4,550	2,840	1:3.0	1:1.1

[1] Represents weights of motor trucks, excluding trailers.
[2] Light, 1½ tons and under; medium, between 1½ and 5 tons; heavy, 5 tons and over.
[3] Average about 1⅛ tons.
[4] Average about 2¼ tons.
[5] Average about 5 tons.
[6] Average about 1¼ tons.

SEVEN-EIGHTHS OF ALL LOADED TRUCKS WEIGHED LESS THAN 6 TONS

The frequency distributions of empty and loaded trucks of various capacities, according to average total gross-weight groups, are presented in tables 14

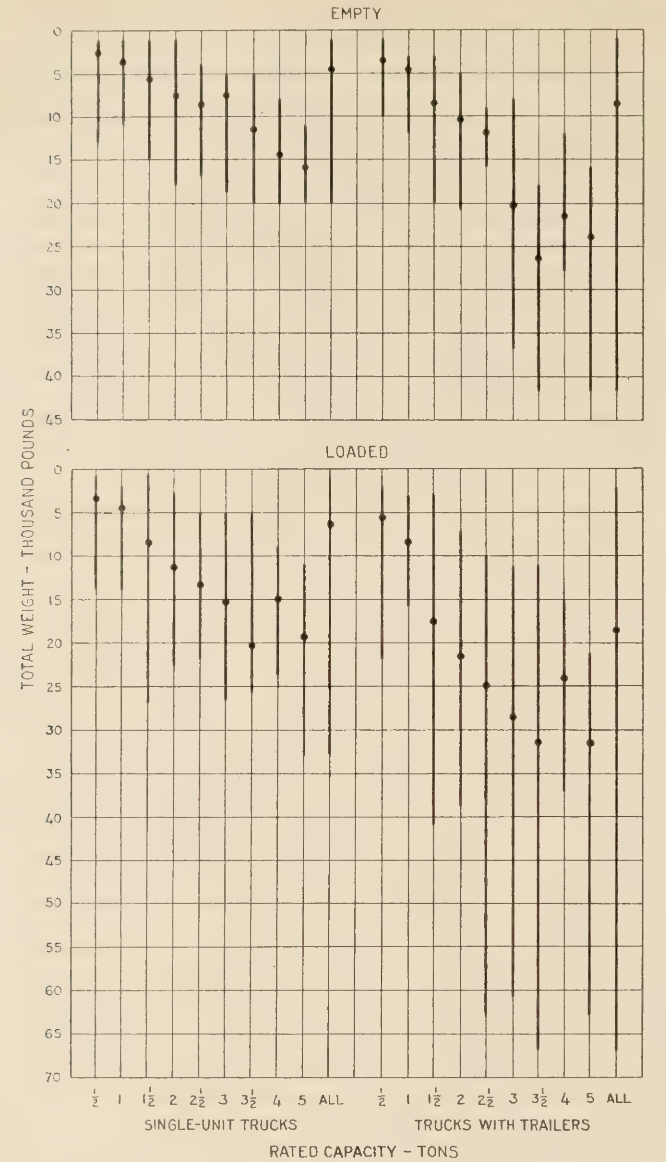

FIGURE 6.—TOTAL GROSS WEIGHTS OF EMPTY AND LOADED SINGLE-UNIT TRUCKS AND TRUCKS WITH TRAILERS OF EACH RATED CAPACITY, SHOWING RANGE AND MEDIAN POINT.

and 15. Figure 6 gives this same information in graphic form, showing the range and median point among weights of trucks of each rated capacity. This figure also includes corresponding information relating to trucks with trailers. In the tables, actual numbers have been converted to the number of trucks per thousand in the sample for each class, respectively, thus making possible general comparisons in each table. These figures can be converted into percentages by placing a decimal point in front of the last digit of each.

GROSS LOADS OF TRUCKS WITH TRAILERS—GENERAL CLASSIFICATIONS

Average gross axle and trailer loads of truck-trailer combinations, according to trip, operation, and ownership classifications, are presented in table 16. Corresponding figures for trucks with trailers which carried loads of various kinds are shown in table 17. A comparison of the relative importance of front axle, rear axle, and trailer loads in each of these classifications is shown graphically in figure 7.

Special information with regard to foreign passenger-car traffic was obtained at survey stations near the Arkansas border during the regular operations of these stations.

TABLE 14.—*Frequency distribution of empty trucks recorded at 25 stations by rated capacity and total weight groups*

Total weight	Number of trucks per thousand in sample for rated capacities of—									
	½ ton [1]	1 ton [2]	1½ tons	2 tons	2½ tons	3 tons	3½ tons	4 tons	5 tons	All capacities
Pounds										
1,000– 1,999	11	1	(3)	(3)	----	----	----	----	----	12
2,000– 2,999	173	14	3	(3)	----	----	----	----	----	190
3,000– 3,999	161	20	55	(3)	----	----	----	----	----	236
4,000– 4,999	10	10	155	1	(3)	----	----	----	----	177
5,000– 5,999	1	2	200	4	(3)	1	(3)	----	----	209
6,000– 6,999	(3)	1	89	7	(3)	1	(3)	----	----	98
7,000– 7,999	(3)	(3)	24	9	(3)	1	(3)	----	----	36
8,000– 8,999	(3)	(3)	9	5	(3)	1	(3)	(3)	----	15
9,000– 9,999	(3)	----	4	4	(3)	1	----	(3)	----	9
10,000–10,999	----	(3)	1	2	1	1	----	----	----	5
11,000–11,999	----	----	1	(3)	(3)	(3)	2	(3)	(3)	4
12,000–12,999	(3)	----	(3)	1	(3)	1	(3)	----	(3)	2
13,000–13,999	----	----	(3)	(3)	(3)	1	(3)	----	(3)	2
14,000–14,999	----	----	(3)	(3)	----	1	(3)	(3)	(3)	2
15,000–15,999	----	----	----	(3)	----	(3)	(3)	----	(3)	1
16,000–16,999	----	----	----	(3)	(3)	(3)	(3)	----	(3)	1
17,000–17,999	----	----	----	(3)	----	(3)	(3)	----	(3)	1
18,000–18,999	----	----	----	----	----	(3)	----	----	(3)	(3)
19,000–19,999	----	----	----	----	----	----	(3)	(3)	(3)	(3)
All weight groups	357	48	542	33	3	10	4	1	2	1,000

1 Includes two ¼-ton trucks.
2 Includes two ¾-ton trucks.
3 Less than one per thousand.

TABLE 15.—*Frequency distribution of loaded trucks recorded at 25 stations, by rated capacity and total weight groups*

Total weight	Number of trucks per thousand in sample for rated capacities of—									
	½ ton [1]	1 ton [2]	1½ tons	2 tons [3]	2½ tons [4]	3 tons	3½ tons	4 tons	5 tons [5]	All capacities
Pounds										
1,000– 1,999	4	----	(6)	----	----	----	----	----	----	4
2,000– 2,999	60	4	1	----	----	----	----	----	----	65
3,000– 3,999	140	12	9	(6)	----	----	----	----	----	162
4,000– 4,999	56	14	36	(6)	----	----	----	----	----	106
5,000– 5,999	12	10	74	1	(6)	(6)	(6)	----	----	97
6,000– 6,999	2	6	77	2	(6)	(6)	(6)	----	----	88
7,000– 7,999	(6)	3	77	3	(6)	(6)	(6)	----	----	84
8,000– 8,999	(6)	2	74	4	(6)	(6)	(6)	----	----	82
9,000– 9,999	(6)	1	66	6	(6)	1	----	(6)	----	74
10,000–10,999	(6)	(6)	50	6	1	(6)	(6)	(6)	----	58
11,000–11,999	(6)	(6)	41	7	1	1	(6)	(6)	(6)	50
12,000–12,999	(6)	(6)	29	5	(6)	1	(6)	(6)	----	37
13,000–13,999	(6)	(6)	22	5	1	1	(6)	(6)	(6)	29
14,000–14,999	----	----	14	5	1	1	----	(6)	(6)	21
15,000–15,999	----	----	8	4	1	1	(6)	----	(6)	14
16,000–16,999	----	----	4	3	1	1	(6)	(6)	(6)	9
17,000–17,999	----	----	1	2	(6)	1	(6)	(6)	(6)	5
18,000–18,999	----	----	1	2	(6)	1	(6)	(6)	(6)	5
19,000–19,999	----	----	(6)	1	(6)	1	(6)	(6)	(6)	3
20,000–20,999	----	----	----	1	(6)	(6)	2	(6)	(6)	4
21,000–21,999	----	----	----	(6)	(6)	1	(6)	----	(6)	2
22,000–22,999	----	----	(6)	(6)	----	(6)	(6)	(6)	(6)	1
23,000–23,999	----	----	----	----	----	(6)	----	(6)	(6)	(6)
24,000–24,999	----	----	----	----	----	----	----	----	(6)	(6)
25,000–25,999	----	----	----	----	----	----	(6)	----	(6)	(6)
26,000–26,999	----	----	(6)	----	----	(6)	----	----	----	(6)
27,000–27,999	----	----	----	----	----	----	----	----	----	------
28,000–28,999	----	----	----	----	----	----	----	----	----	------
29,000–29,999	----	----	----	----	----	----	----	----	(6)	(6)
30,000–30,999	----	----	----	----	----	----	----	----	----	------
31,000–31,999	----	----	----	----	----	----	----	----	(6)	(6)
32,000–32,999	----	----	----	----	----	----	----	----	(6)	(6)
All weight groups	276	53	585	57	8	13	4	1	3	1,000

1 Includes one ¼-ton truck.
2 Includes six ¾-ton trucks.
3 Includes one 1¾-ton truck.
4 Includes one 2¼-ton truck.
5 Includes one 7½-ton truck.
6 Less than one per thousand.

The special information was obtained from post-card questionnaires requiring no postage, distributed to foreign passenger-car operators at border stations. The driver was asked to give the following data: (1) Whether trip was for business or pleasure; (2) number of occupants of the car; (3) number of miles driven in Arkansas; (4) number of days stay in Arkansas; (5) type of accommodation used, such as hotels, tourist camps, etc., or "driving through"; and (6) State in which the car was registered.

Approximately 6,500 cards were returned, or 28 percent of those distributed. The number of cards returned ranged from 22 to 39 percent of those distributed at individual stations.

SEVENTY-FIVE PERCENT OF FOREIGN PASSENGER-CAR TRAFFIC ORIGINATED IN FIVE ADJACENT STATES

Table 18 shows the average daily and annual foreign passenger-car traffic at 51 stations located near the Arkansas border.

Foreign passenger-car traffic recorded at these points was used in computing the daily and annual traffic entering and leaving Arkansas. At the 51 stations shown in table 18 a total annual traffic of 2,983,800 foreign passenger cars was estimated to have entered or left Arkansas during the year. Half of this traffic, 1,491,900 vehicles, was assumed to have entered the State.

Since the tourist traffic entering or leaving Arkansas is not concentrated during any period of the year, the foreign passenger-car traffic entering the State was assumed to have had the same seasonal variation as all foreign passenger-car traffic recorded within the State.

The State of registration as determined from license tags provided a means of accurately estimating the volume of foreign passenger-car traffic by State of origin.

The origin of tourist traffic—foreign passenger-car traffic—is summarized by areas in table 19. In figure 8 the areas within the circles show the relative volume of tourist traffic originating in each geographical section.

Table 16.—*Number and average axle and trailer loads of trucks with trailers recorded at 25 stations, by various classifications*

Classification	Number of truck trailer combinations	Average gross loads						
		Truck				Trailer		Total weight
		Front axle		Rear axle				
		Weight	Percentage of total load	Weight	Percentage of total load	Weight	Percentage of total load	
Trip classification:		*Pounds*		*Pounds*		*Pounds*		*Pounds*
State	2,900	2,310	16.8	6,260	45.6	5,170	37.6	13,740
Interstate	2,281	2,360	14.7	7,200	44.9	6,480	40.4	16,040
Trans-State	476	2,610	14.4	8,170	44.9	7,400	40.7	18,180
Total	5,657	2,360	15.7	6,800	45.2	5,880	39.1	15,040
Class of operation:								
Private operator	2,863	2,190	16.9	5,920	45.6	4,860	37.5	12,970
Contract hauler	1,836	2,300	14.7	7,160	45.5	6,250	39.8	15,710
Common carrier	951	2,960	14.9	8,750	43.9	8,220	41.2	19,930
Total	5,650	2,360	15.7	6,800	45.2	5,880	39.1	15,040
Situs of ownership:								
Farm	219	1,820	19.2	4,270	45.0	3,400	35.8	9,490
City—Private	2,100	2,050	16.0	5,900	46.0	4,870	38.0	12,820
City—Company	3,335	2,590	15.4	7,530	44.8	6,680	39.8	16,800
Total	5,654	2,360	15.7	6,800	45.2	5,880	39.1	15,040

Table 17.—*Number and average axle and trailer loads of trucks with trailers recorded at 25 stations, by nature of load carried*

Nature of load carried	Number of truck trailer combinations	Average gross loads						
		Truck				Trailer		Total weight
		Front axle		Rear axle				
		Weight	Percentage of total load	Weight	Percentage of total load	Weight	Percentage of total load	
Commercial commodities.		*Pounds*		*Pounds*		*Pounds*		*Pounds*
Manufactured products	2,243	2,580	13.7	8,620	45.5	7,730	40.8	18,930
Agricultural products	720	2,230	11.9	8,480	45.3	8,020	42.8	18,730
Mineral products, oil	82	2,360	13.3	8,050	45.5	7,300	41.2	17,710
Forest products	465	2,070	11.8	8,310	47.4	7,130	40.8	17,510
Total	3,510	2,440	13.1	8,540	45.7	7,690	41.2	18,670
Other types of load:								
Passengers	57	2,000	23.6	4,050	47.6	2,450	28.8	8,500
Household goods	76	2,040	17.7	5,370	46.6	4,120	35.7	11,530
Highway materials	32	2,360	18.8	5,460	43.4	4,760	37.8	12,580
Total	165	2,090	19.6	4,930	46.1	3,670	34.3	10,690
All types of load	3,675	2,420	13.2	8,380	45.7	7,520	41.1	18,320
Empty	1,971	2,230	25.0	3,860	43.2	2,830	31.8	8,920
Grand total	5,646	2,360	15.7	6,800	45.2	5,880	39.1	15,040

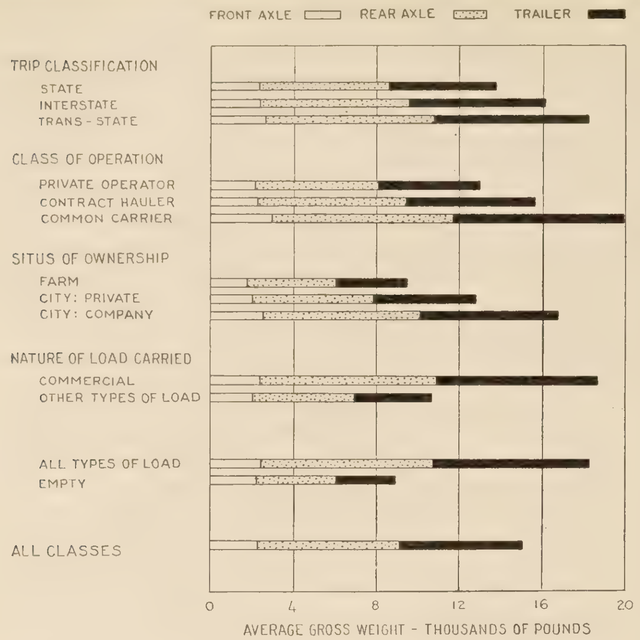

FIGURE 7.—AVERAGE GROSS AXLE AND TRAILER LOADS OF TRUCK-TRAILER COMBINATIONS RECORDED AT 25 STATIONS BY VARIOUS CLASSIFICATIONS.

Except for five States adjacent to Arkansas—Louisiana, Missouri, Oklahoma, Tennessee, and Texas—the census grouping of States was used in figure 8. This grouping of States serves very well and makes possible comparisons with populations of these areas, should this be desired.

The small amount of traffic originating in Mississippi does not justify showing its traffic separately. The shortage of desirable crossings over the Mississippi River, a natural traffic barrier, accounts for the small volume of traffic from Mississippi, although there are suitable ferries at Helena and Lake Village. A bridge across the Mississippi River at Vicksburg also tends to divert traffic into Louisiana.

Most of the foreign passenger-car traffic originated in adjacent States. More than 75 percent of total foreign traffic had its origin in the six bordering States. The greatest amount of this traffic from a single geographical area had its origin in Missouri. An estimated total of 293,900 vehicles, or 19.7 percent of total was from that State.

Tennessee with 18.5 percent of the total, or 276,000 vehicles, was second in amount of foreign passenger-car traffic found upon Arkansas highways. Much of this movement of traffic from Tennessee was through Memphis. The Memphis bridge is the only one across the Mississippi River along the Arkansas border, and there was a considerable amount of across-the-border movement with a short trip mileage which was balanced by a large amount of long trips across the State.

Texas, with a comparatively small amount of mileage bordering Arkansas, was the origin of 14 percent, or 208,900 vehicles, of the foreign passenger vehicles estimated to have entered Arkansas. Oklahoma with 12.6 percent and Louisiana with 10.2 percent accounted for the origin of 188,000 and 152,200 vehicles respectively, on Arkansas highways. The percentage of total and the number of vehicles originating in other areas are shown in table 19.

Excepting Tennessee and the East North Central States, the territory east of the Mississippi was not a source of much of the State's tourist traffic. The East North Central States contributed 7.8 percent, or

TABLE 18.—*Average daily and estimated annual foreign passenger-car traffic at 51 stations near the Arkansas border*

Station number	Route	Foreign passenger cars	
		Daily	Annual [1]
1 NE	U S 67	152	55, 500
2 N	U S 63	293	106, 900
5	U S 61 and 70	2, 481	905, 600
17	U S 82	55	20, 100
18	U S 71	67	24, 500
19	U S 67	432	157, 700
20	U S 71 [2]	138	50, 400
22	U S 71 [2]	138	50, 400
23	Ark. 22	156	56, 900
24 SW	U S 64	253	92, 300
26 E	U S 62	88	32, 100
30 N	U S 61	864	315, 400
37 SE	Ark. 131	27	9, 900
61 N	U S 65	93	33, 900
62 N	Ark. 47	197	71, 900
63 N	U S 71	246	89, 800
63 W	Ark. 102	57	20, 800
64 W	Ark. 59	317	115, 700
65 W	U S 62	87	31, 800
75 SW	Ark. 45	25	9, 100
76 NE	Ark. 20	86	31, 400
77 E	Ark. 20	86	31, 400
97 S	Ark. 13	36	13, 100
100 SE	U S 65	102	37, 200
100 SW	Ark. 159	68	24, 800
115	U S 167	185	67, 500
121 NW	Ark. 32	32	11, 700
122 W	U S 70	74	27, 000
200 E	Ark. 90	44	16, 100
203 E	Ark. 25	236	86, 100
204 N	Ark. 77	99	36, 100
241	Ark. 115	23	8, 400
242 N	Ark. 93	7	2, 600
246 N	Ark. 5	23	8, 400
255 NE	Ark. 21	37	13, 500
259	Ark. 100	115	42, 000
270	Ark. 28	18	6, 600
275	U S 270	68	24, 800
276	Ark. 88	19	6, 900
278 W	Ark. 4	26	9, 500
290	U S 71	55	20, 100
291	Ark. 29	90	32, 800
292	Ark. 132	50	18, 200
294	U S 79	119	43, 400
295	Ark. 15	3	1, 100
298	Ark. 129	35	12, 800
299	Ark. 133	48	17, 500
300	U S 165	80	29, 200
303 SE	Ark. 142	9	3, 300
304 NE	U S 82	128	46, 700
307	Ark. 4	8	2, 900
Total		8, 175	2, 983, 800
Estimated number entering State		4, 088	1, 491, 900

[1] Annual traffic estimated by multiplying daily average by 365; individual station estimates of annual traffic adjusted to the nearest 100 vehicles.
[2] Station 20 was located near the Texas line; station 22 was located near Fort Smith.

TABLE 19.—*Origin of foreign passenger-car traffic in Arkansas*

Geographical area	Estimated annual traffic	Percentage distribution
Louisiana	152, 200	10. 2
Missouri	293, 900	19. 7
Oklahoma	188, 000	12. 6
Tennessee	276, 000	18. 5
Texas	208, 900	14. 0
New England States	6, 000	. 4
Middle Atlantic States	25, 400	1. 7
East North Central States	116, 400	7. 8
West North Central States except Missouri	86, 500	5. 8
South Atlantic States	32, 800	2. 2
East South Central States except Tennessee	49, 200	3. 3
Mountain States	16, 400	1. 1
Pacific States	37, 300	2. 5
Other [1]	3, 000	. 2
Total	1, 492, 000	100. 0

[1] Includes cars from Canada, Mexico, Panama, Puerto Rico, and Hawaii.

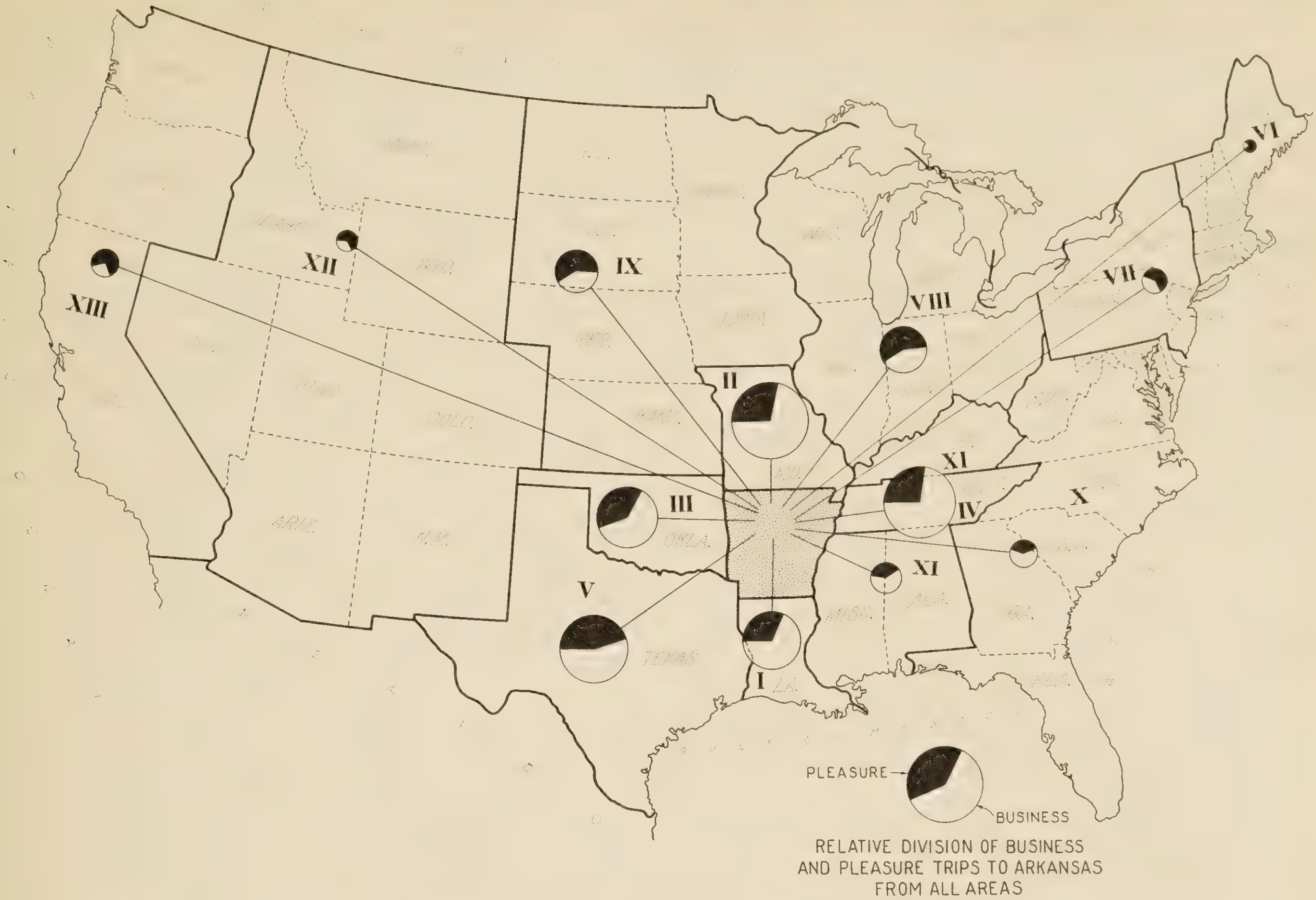

FIGURE 8.—ORIGIN OF FOREIGN PASSENGER-CAR TRAFFIC IN ARKANSAS.

116,400 vehicles. The remaining territory east of the Mississippi River was responsible for less traffic than that of the East North Central States.

A little less than 6 percent of the foreign passenger cars that used Arkansas highways originated in the West North Central States (except Missouri), and about 59 percent of all cars from this area had their origin in Kansas.

Distance is not always the reason for a small amount of traffic from a particular State, as illustrated by the fact that California contributed 97 percent of the 37,300 foreign passenger cars that had their origin in the Pacific States.

More than twice as many cars had their origin in California as in the eight Mountain States. However, California has the second largest motor-vehicle registration of any State in the Union.

Slightly more than 0.2 percent of the foreign passenger cars had their origin outside of the continental United States, or were government cars which could not be distributed by areas of origin. These cars carried licenses from Canada, Mexico, Panama, Puerto Rico, and Hawaii.

HIGHWAY RESEARCH BOARD TO MEET IN DECEMBER

The Sixteenth Annual Meeting of the Highway Research Board of the National Research Council will be held in Washington, D. C., on November 18–20, 1936. A program of reports on research investigations is to be announced in the near future.

THE CONE METHOD FOR DETERMINING ABSORPTION BY SAND

BY THE DIVISION OF TESTS, BUREAU OF PUBLIC ROADS

Reported by D. O. WOOLF, Associate Materials Engineer

THE NEED for an accurate method of determining the absorption of water by aggregates has been recognized ever since the design of concrete mixtures was approached on the basis of scientific principles. Only a portion of the water used in mixing concrete is needed for the complete hydration of the cement. The rest is necessary to lubricate the mix so that it may be placed uniformly and without undue difficulty. Some of this lubricating water may be absorbed by the aggregates, but the remainder, the so-called "free" water, dilutes and weakens the cement paste. Consideration of the strength of the resulting concrete must involve the amount of this diluting water, and a knowledge of the amount of water absorbed by the aggregates is necessary to determine the net water content available for the cement. The determination of the bulk specific gravity and from this the bulk volume and weight of the aggregates required for a given yield of concrete also necessitates a determination of the amount of absorbed water.

Methods of determining the water absorption of fine aggregate by means of a simple yet reasonably accurate test have been given considerable attention during the past several years and a number of methods have been devised. The majority of the procedures so far suggested are based on the observed behavior of sand grains in the presence of free moisture. Extensive study by the Bureau of Public Roads has disclosed that most of these methods are either liable to furnish inaccurate results or require such great care and are so sensitive to nominally uncontrolled variables that their use in routine testing is not warranted.

After reviewing briefly the various procedures that have been suggested, this report discusses the so-called "cone method" which has been developed by the writer after considerable study of this problem.

VISUAL INSPECTION AND KEROSENE METHODS REVIEWED

Probably the first method used for determining the condition usually known as "saturated and surface-dry", when the permeable pore spaces in the sand grains are filled with water without any moisture adhering to the surfaces of the grains, was by simple visual inspection. The procedure is simply to spread the sand out on a smooth surface and permit it to air dry, with or without artificial circulation. The sample is stirred frequently to insure uniform drying, and the end point is determined by noting when the sand appears to be surface-dry and free-flowing. The difference in the weight of sand in the saturated and surface-dry condition and the oven-dry weight is termed the absorption and is expressed as a percentage of the oven-dry weight.

This method has been considered capable of furnishing consistent results when used by a single operator but considerable doubt has been expressed as to the ability of different operators to check each other's results since the end point depends entirely on the operator's judgment. The development of a method with the end point based on measurable features was considered advisable.

In 1917, A. S. Rea presented a method of determining the so-called "apparent" specific gravity of nonhomogeneous fine aggregates.[1] This value for specific gravity, more properly called the "bulk" specific gravity, is defined as the ratio of the weight in air of a given volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight of an equal volume of distilled water at the same temperature.[2] An accurate determination of this value requires that the permeable voids in the material under test be filled with water or some other substance, or that the voids be sealed against the entrance of water by some method before the volume of the displaced water is determined. Rea accomplished this by coating the sand grains with kerosene before determining the volume of the test sample.

It is apparent that if the bulk specific gravity can be determined by this kerosene method, the absorption of the material tested can also be determined. By means of a slight change, the method was later adapted to determine the absorption of fine aggregate.[3] In this method, duplicate 500-gram samples of oven-dried sand are placed in 500-milliliter volumetric flasks. A small amount of kerosene is added to one flask and the flask shaken to distribute the kerosene over all the sand grains. It is intended that the kerosene shall coat each sand grain to prevent absorption of water. The volume of a normal salt solution [4] required to fill the flask is then found. The excess kerosene floats on the top of the salt solution. A measured quantity of water is added to the second flask and the sand permitted to absorb water for a definite length of time. The volume of water required to fill the flask is then determined. The absorption is computed from the difference between the volume of water required to fill the flask containing the untreated sand and the volume of salt water required to fill the flask containing the kerosene-coated sand.

Although this method appears to be satisfactory in theory, a number of difficulties developed in actual practice. The most troublesome feature is found when sand containing clay or other fine particles is tested. Much of this fine material adheres to the globules of surplus kerosene and floats on the salt water. Shaking the flask or stirring the liquid seems to promote the formation of an emulsified liquid containing kerosene, salt water, clay or other fine particles, and air. A clean line of demarcation between the salt water and kerosene is seldom found, and in many cases only an approximate measurement of the amount of salt water required to fill the flask can be made.

For accurate determinations the test can be made only on thoroughly clean sand containing little if any fine particles. Reports from a number of different

[1] Proceedings, American Society for Testing Materials, vol. 17, pt. II, p. 257.
[2] Standard Definition E 12-27, American Society for Testing Materials. Book of Standards, 1933, p. 1252.
[3] Proceedings, American Society for Testing Materials, vol. 20, pt. I, pp. 301-302 (1920).
[4] The higher density of the normal salt solution gives a better separation of the kerosene than would be obtained with the use of water.

laboratories occasionally have shown negative values for tests made by this method. The writer is of the opinion that rolling and shaking the flask to remove surplus kerosene and entrapped air also tends to remove the kerosene film from the sand grains, allowing the sand to absorb water. This absorption, together with the flotation of fine particles by the kerosene emulsion, may cause the volume of salt water to exceed that of the fresh water, and a negative result is obtained.

OTHER METHODS DISCUSSED

In 1929 J. C. Pearson suggested [5] a new method of determining the absorption by sand. In this method a 200-gram sample of dry sand is placed in an Erlenmeyer flask and water added drop by drop until the finer grains adhere to the sides of the flask after thorough shaking. The weight of the flask and contents is then found; the sand is further dampened by several drops of water; and the sample is dried until the sand grains no longer adhere to the flask. The weight of flask and contents is again determined, and the average weight of the moistened sand is used in computing the absorption. This method has one major defect in that sufficient time for the complete absorption of the added water is not permitted. Consequently, the method may furnish results lower than the true absorption of the material under test.

In 1933, the American Society for Testing Materials adopted as tentative a method [6] for determining the absorption by sand. This method is based on Pearson's titration method. In the test, a sample of sand is thoroughly saturated with water, and then dried to a surface-dry condition as determined by visual examination. A 500-gram sample is taken from this saturated and surface-dry sand, and placed in a 1-quart glass jar. Water is added to the sample, drop by drop, with thorough shaking until the sand grains just tend to adhere to the sides of the jar. The weight of the sample is then found, and the sample dried to constant weight. The results of this method are in effect largely dependent on the accuracy of the operator's judgment that the sample is in a saturated and surface-dry condition. If drying of the sample is stopped exactly when the sand becomes surface-dry, the addition of one or two drops of water will indicate the end point; if the sample is dried past the surface-dry condition, the addition of one or two drops of water may indicate a false end point unless sufficient time is permitted for the absorption of the added water.

Chapman [7] has suggested that the saturated and surface-dry condition of sand can be determined from the change in color of the material when uniformly dried, and Graf and Johnson [8] have stated their belief that this condition can be determined by drying sand for several days over calcium chloride. It is doubted that the exact point of change in color can be precisely and repeatedly determined, or that desiccation will not r move some of the absorbed water.

In addition to the methods that have already been described, Myers [9] has presented a review and discussion of a number of methods based on gravimetric, displacement, dilution, colorimetric, and electrical-resistance principles. Many of these methods are primarily concerned with the determination of the free moisture in the aggregate, the accuracy of which depends upon placing the sand initially in a saturated and surface-dry condition by visual inspection.

Since none of the available methods were considered to combine the desirable characteristics of simplicity, ease of performance, and accuracy, an effort was made to devise a better method. Attention was first given to the possibility of mixing the sand with a material of known density and determining the density of the two substances combined. A number of oils and plastic materials were tried, but the method proved unsuccessful when sands containing finely divided particles were used. Recourse was then made to the method based on Rea's kerosene test for specific gravity, and tests conducted to find a substitute for kerosene that would furnish better results. None of the materials used gave any better results than kerosene, and further work along this line was abandoned.

DEVELOPMENT OF CONE METHOD DESCRIBED

An attempt was then made to use a very simple procedure. It was known that moist sand containing free water could be formed into shapes by light pressure and that dry sand could not. This characteristic has long been utilized in foundries in making molds for the casting of metal objects. If this feature could be used in a method of test it might prove a satisfactory means of determining the saturated and surface-dry condition of sand. Preliminary tests were made using a small, hollow, metal cone which was available. The sand was placed loosely in the cone and compacted by tamping it lightly with a metal rod having a flat face 1 inch in diameter. It was found that if the sand was dry the material would slump when the cone was removed, but if the sand contained free moisture the cone of sand would retain its form.

Further tests were made using right truncated cones having base angles of approximately 45°, 60°, 70°, and 80°. Samples of sand were immersed in water for 24 hours, drained, and dried to a free-flowing condition by a current of warm air. As the sand approached a surface-dry condition, tests were repeatedly made with each of the cones to determine the point at which the sand would slump when lightly tamped in the cone and the cone removed. The 45° and 60° cones did not prove practical. These angles were not sufficiently different from the natural angle of repose of the sand, and a definite slump was seldom obtained, especially when the sand contained clay.

The 80° cone gave a sharp point of slump, but a microscopic examination of the sand disclosed the presence of an appreciable amount of free water. The 70° cone also gave a definite point of slump. Microscopic examination of the sand at this point failed to show any evidence of free moisture, and it is believed that the use of the 70° cone determines the condition of the sand which is very close to that of the desired "saturated and surface-dry" material. The addition of a few drops of water to the test sample in the above condition caused the sand to retain its form after removal of the 70° cone, thus indicating the presence of free moisture.

There seems to be considerable divergence of opinion as to the reason for the cohesion developed by moist

[5] A Simple Titration Method for Determining the Absorption of Fine Aggregates by J. C. Pearson. Rock Products, vol. 32, no. 10, p. 64, May 11, 1929.

[6] Method C 95–33 T: Tentative Test for Absorption by Aggregates for Concrete (laboratory determinations).

[7] Discussion of Comparison of Methods of Determining Moisture in Sands. Proceedings, American Concrete Institute, vol. XXV, p. 261 (1929).

[8] Study of Methods for Determining Moisture in Sand, by S. H. Graf and R. H. Johnson. Proceedings, American Society for Testing Materials, vol. 30, pt. I, p. 578 (1930).

[9] Free Moisture and Absorption of Aggregates, by Bert Myers, in Report on Significance of Tests of Concrete and Concrete Aggregates, Committee C–9, American Society for Testing Materials, 1935.

sand. P. G. Nutting[10] has stated that surface tension, vapor tension, atmospheric pressure, and internal (adsorption) pressure are the forces involved in causing the observed cohesion and resistance to deformation of moist sand. This cohesional force increases with the amount of water present up to a maximum and then falls to zero with complete wetting.

Nutting further states that silica will adsorb a film of water from 50 to 100 molecules deep and that in coarse sand this water may amount to 1 milligram per gram of sand. However, this film of adsorbed water can be removed from sand grains only by extended desiccation or heating to a high temperature. The presence of this adsorbed water cannot be held the sole cause of the cohesion in damp sand since it is present in sand dried at 100° C. as well.

Other physicists do not agree with these views. It has been stated by one authority that absorbed water cannot be distinguished from adsorbed water, and that whether the water and the sand are physically or chemically combined, the cohesion of moist sand is caused only by the presence of water on the surface of the sand grains. Another has stated that adsorbed moisture is present in moist sand in very small amounts as a monomolecular film, but that this water behaves as free water and joins with any other moisture present in binding the sand grains together when the damp sand is compacted. That the monomolecular film of adsorbed water can by itself produce the cohesion of sand is doubted.

In general, the opinion seems to be that whatever the nature of the water in damp sand, a change in the cohesiveness of sand may be taken as an indication of a change in the condition of the sand from one in which free moisture exists on the surfaces of the grains to one in which no free moisture is present. Free moisture is here considered as that which causes the bulking of sand. Whether or not adsorbed moisture is present in the noncohesive sand seems to be a moot point. It seems to be generally agreed that the amount of this adsorbed water is so small, compared to the total "absorption" determined by this test, that it can have no practical effect on either the bulk specific gravity or the net water-cement ratio. The test is considered to be a logical if possibly an empirical method of determining a usable value by means of a readily standardized procedure.

PROCEDURE FOLLOWED IN MAKING CONE TEST OUTLINED

On the basis of the preliminary tests, a method for determining the absorption by sand was formulated as follows:

A 1,000-gram sample of sand shall be placed in a pan and covered with water for a period of at least 3 hours. The sample shall then be drained, placed in a large enamelware pan, and exposed to a gentle current of warm air. The sand shall be stirred frequently to insure uniform drying. When the sand appears to be approaching a surface-dry condition, trial determinations with the cone shall be started. A sheet metal cone with top and bottom diameters of 1½ and 3½ inches, respectively, and a height of 2⅞ inches, shall be placed in the pan and filled with sand which shall be lightly tamped 25 times with a 12-ounce metal rod having a flat face 1 inch in diameter. The cone shall then be lifted vertically. If the sand does not slump, free moisture is still present, and the drying shall be resumed. Trials with the cone shall be continued at frequent intervals until the sand slumps upon removal of the cone. This indicates that the sand has reached a surface-dry condition and the weight of the sample shall be determined. To insure that the sand has not been dried too much, a few drops of water shall be mixed with the sand, and the cone test repeated. Under these conditions, free water should be present, and the cone of sand should not slump. The weight of the sample shall again be determined, and the sample oven-dried to constant weight. The percentage of absorption shall be computed from the average of the two weights of the dampened sand and from the oven-dry weight.

Figure 1 shows the method of tamping the sand in the cone, a cone of a sand containing free moisture, and a slumped cone of the same sand after the material had reached a surface-dry condition.

In making the cone test, the following features should be observed:

1. The sample should be stirred frequently to obtain uniform drying.
2. The first trial for slump should find the sample with free moisture present.
3. Successive trials should be made at frequent intervals. The practice in the laboratory of the Bureau is to dry the sample under artificial circulation of air. As the sand approaches the surface-dry condition, drying is continued for definite lengths of time and trial determinations made at more and more frequent intervals. Under closely controlled conditions, ½-minute drying periods are used immediately prior to determination of the point of slump.
4. The metal cone should be lifted vertically. If it is not carefully removed, the sand cone may be struck and caused to slump prematurely.

One criticism of the cone method which has been made is that the test result obtained is influenced by the surface area of the sand grains. To investigate this, a series of tests was made with the cone method on several different gradings of five different sands. In preparing each set of test samples, a large amount of sand was separated into different sizes by sieving, and a series of samples definitely graded from coarse to fine was obtained. If the cone method results were influenced by the surface area of the material, it would be expected that the test value would be increased with change in the grading from coarse to fine. As shown in table 1, however, the percentage of absorption decreased slightly with increase in fineness for each sand. These results indicate that the larger grains have a somewhat higher ratio of volume of permeable voids to volume of grain than is found in finer sand. The greater absorption of the larger grains may explain the usual results of the accelerated soundness test for sand in which the coarser material shows the greater loss.

To shorten the time required for drying the sample, a warm air blower was devised. An 8-inch electric fan was mounted so that the blades rotated in a horizontal plane 24 inches above the table surface, and a sheet-metal tube 12 inches long was fastened to the wire guard around the fan blades. A series of electric resistance coils, drawing 1,250 watts, was mounted in the tube, and a three-speed rheostat was placed in the field circuit of the fan motor. The test sample was placed beneath the opening in the tube and a gently

[10] Some Mechanical Properties of Moist Granular Solids, by P. G. Nutting. Journal, Washington Academy of Sciences, vol. 17, no. 8, p. 185, Apr. 19, 1927.

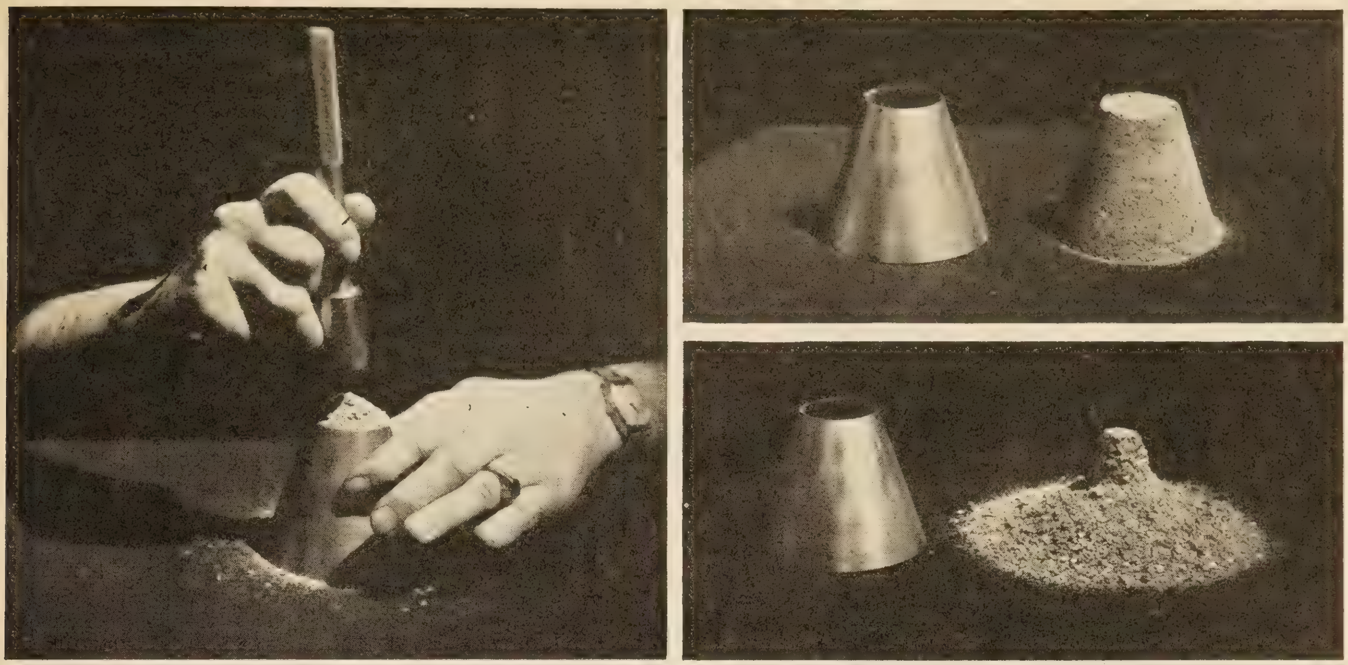

FIGURE 1.—STEPS IN PERFORMING THE CONE TEST ON SAND. LEFT; TAMPING MOIST SAND IN THE CONE. UPPER RIGHT; THIS SAND CONE RETAINED ITS SHAPE INDICATING THE PRESENCE OF FREE MOISTURE. LOWER RIGHT; THIS SAND CONE SLUMPED, INDICATING THAT THE MATERIAL HAD REACHED A SURFACE-DRY CONDITION.

moving current of warm air blown on it. With this apparatus the drying of a sample could be accomplished in about 1 hour.

TABLE 1.—*Comparison between grading of test samples and percentages of absorption*

VARIOUS GRADINGS USED [1]

Item	Grading									
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Sieve no. 4	2	0	0	1	0	1	0	0	0	0
Sieve no. 8	24	25	14	12	8	8	0	0	0	0
Sieve no. 16	46	47	30	27	17	17	4	4	0	0
Sieve no. 30	80	80	73	70	60	60	45	45	40	40
Sieve no. 50	95	95	93	90	85	85	75	75	70	70
Sieve no. 100	100	100	100	97	100	95	100	93	100	90
Fineness modulus	3.47	3.47	3.10	2.97	2.70	2.66	2.24	2.17	2.10	2.00

ABSORPTION BY VARIOUS GRADINGS OF DIFFERENT SANDS

	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
River sand no. 1	1.19			1.19		1.17		1.15		1.14
River sand no. 2 [2]		2.1	1.8		1.8		1.7		1.6	
Pit sand no. 1		2.1			1.9				1.7	
Pit sand no. 2		1.9			1.8				1.5	
Pit sand no. 3		.4			.4				.3	

[1] Values are percentages retained on the various sieves.
[2] Each value is the average of two tests.

TABLE 2.—*Results of cone absorption tests on various sands*

Sample number	Location	Fineness modulus	Absorption	Mineralogical composition [1]
			Percent	
34810	Potomac River, D. C	3.00	1.4	Q, S, C.
34897	do	2.83	1.2	Q, S, C.
34900	do	2.85	1.2	Q, C, S
34901	do	2.84	1.2	Q, C, S.
34902	do	2.81	1.2	Q, C, S.
34904	do	2.96	1.5	Q, C, S.
34919	do	2.87	1.2	Q, C, S.
34921	do	2.76	1.5	Q, C, S.
34922	do	2.86	1.3	Q, C, S.
34927	do	2.87	1.4	Q, S, C.
	Ottawa, Ill.	3.00	.05	Q.
	Bowie, Md		.8	Q, C.
34845	Monroe, Mich	3.00	3.7	Limestone sand.
34618	Albany, N. Y	2.82	2.4	S, Sl, Sh, Q, L.
34804	do	2.81	2.4	S, Sh, Sl, Q, L.
34621	Alexander, N. Y	3.27	1.8	L, Q, Sh, S.
34805	Alfred Station, N. Y	2.53	1.8	S, L, Q, C.
34806	Attica, N. Y	2.60	2.1	S, Sl, Sh, Q, C, L.
34807	Boonville, N. Y	2.88	.6	Q, F, G, C, L.
34623	Clarence, N. Y	2.71	1.7	L, S, Q, Sh, G.
34808	Port Jefferson, N. Y	2.64	.4	Q.
34809	Springville, N. Y	2.85	2.2	S, Sh, Sl, L, Q, C.
34620	Near Utica, N. Y	2.87	2.7	L, Sh, Q, S.
34903	Comanche County, Okla	3.01	1.4	Q, C, F, G.
34826	Silica, Ohio	3.08	1.9	Limestone sand.
34977	do	2.97	1.7	Do.
34861	——, R. I		.6	
34862	do		1.7	
34863	do		.9	
32364	Pon Pon, S. C	2.95	.2	Q.
34942	Elizabethton, Tenn	2.61	1.3	Q, S.
34945	Knoxville, Tenn	2.62	1.3	Q, S, C, M.
34943	Nashville, Tenn	2.55	2.5	Q, S, C.
34944	do	2.67	2.6	Q, C, S.
34940	Siam, Tenn	2.60	1.4	Q, S, G.
34941	do	2.79	1.4	Q, S, G.
34946	Strawberry Plains, Tenn	2.89	.8	Limestone sand.
34908	Fredericksburg, Va	2.97	.9	Q, Sc, Gn.
34844	Martinsburg, W. Va	3.04	.7	Limestone sand.

[1] Explanation of symbols used:

C=Chert Gn=Gneiss Q=Quartz Sh=Shale
F=Feldspar L=Limestone S=Sandstone Sl=Slate
G=Granite M=Mica Sc=Schist

COOPERATIVE ABSORPTION TESTS ON SANDS PERFORMED BY SEVERAL LABORATORIES

Following the establishment of a presumably satisfactory method of test, a large number of tests was made by different operators in the laboratory. Typical values for absorption are given in table 2. The results of these tests were considered so promising that it was decided to submit this method to a number of other laboratories for their criticisms. Several laboratories were accordingly invited to cooperate with the Bureau in an investigation of methods of determining absorption. The following laboratories cooperated in the investigation:

Duquesne Slag Products Co.
Indiana State Highway Commission.
Iowa State Highway Commission.
Michigan State Highway Department.
National Crushed Stone Association.
National Sand and Gravel Association.
Pennsylvania Department of Highways.
Portland Cement Association.
Rhode Island State Board of Public Roads.
Virginia Department of Highways.
West Virginia State Road Commission.
Bureau of Public Roads.

In this series of cooperative tests, each laboratory was requested to make five tests by each of four different methods on each of six different samples of fine aggregate. The methods are included in those previously described, and are designated in the tables and figures that follow by the following numbers:

1. Kerosene method.
2. A. S. T. M. Tentative Method C 95–33 T.
3. Cone method.
4. Visual inspection method.

The samples of fine aggregate used in these tests were obtained by the Bureau, mixed thoroughly, and suitable portions of each sent to the cooperating laboratories. Effort was made to obtain sands having a considerable range in absorption, and the samples selected were as shown in table 3.

TABLE 3.—*Sands used in cooperative tests*

Sand	Source	Mineralogical composition
1	Massachusetts	Quartz, granite, diorite, rhyolite, feldspar, sandstone.
2	New York	Limestone, sandstone, quartz, chert.
3	South Carolina	Quartz.
4	Kansas	Quartz, feldspar, chert.
5	Rhode Island	Quartz, feldspar, granite, slate.
6	Ohio	Limestone (crushed stone sand).

The results of this series of cooperative tests are shown in tables 4, 5, and 6, and figures 2, 3, and 4. Tests were made in one laboratory by three different operators, and the results for this laboratory are shown in table 4. The individual results for each of the other laboratories are shown in table 5 and the average values for each laboratory, sand, and method are grouped together to permit ready comparison in table 6.

Figure 2 gives the average value obtained by all laboratories for each sand by each method of test. With the exception of sand number 3, the values obtained by the use of the kerosene method are considerably lower than those for the other test methods. This may have been caused by the removal of a portion of the kerosene from the sand grains when the flask was shaken to free the excess kerosene, or it may have been caused by the retention of a portion of the sample by the floating kerosene. In either case the result would be the same in that an excessive quantity of salt water would be added to the flask. This would of course decrease the difference between the volumes of fresh and salt water and would furnish a low value for the percentage of absorption. The average values for the cone method were found to be slightly higher than those for the tentative A. S. T. M. or visual inspection methods, but the difference in results was marked only in the case of the stone sand sample, number 6.

TABLE 4.—*Individual test results of percentage of absorption for laboratory no. 1*

Sand	Test	Method 1, operator		Method 2, operator			Method 3, operator			Method 4, operator		
		1	2	1	2	3	1	2	3	1	2	3
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	1	0.1	0.3	0.6	0.6	0.8	0.8	0.8	0.8	0.6	0.6	0.8
	2	.2	.3	.7	.7	.6	.7	.8	.8	.7	.7	.7
	3	.1	.1	.8	.8	.7	.8	.8	.8	.7	.8	.7
	4	.0	.3	.8	.8	.8	.9	.8	.9	.8	.8	.7
	5	.0	.3	.9	.8	.7	.7	.7	.8	.9	.8	.7
	Average	.1	.3	.8	.7	.7	.8	.8	.8	.7	.7	.7
2	1	.5	.8	1.5	1.4	1.8	1.6	1.6	1.9	1.5	1.5	1.8
	2	.4	.5	1.7	1.6	1.9	1.7	1.7	1.8	1.7	1.5	1.9
	3	.4	.6	1.6	1.5	1.7	1.7	1.8	1.8	1.6	1.5	1.8
	4	.3	.6	1.7	1.7	1.8	1.7	1.8	2.0	1.7	1.6	1.8
	5	.1	.8	1.4	1.6	2.0	1.7	1.7	2.0	1.7	1.6	2.0
	Average	.3	.7	1.6	1.6	1.8	1.7	1.7	1.9	1.6	1.5	1.9
3	1	.2	.1	.2	.1	.2	.2	.2	.2	.2	.1	.2
	2	.2	.2	.2	.2	.2	.3	.2	.3	.2	.2	.2
	3	.2	.1	.2	.1	.2	.2	.2	.3	.2	.1	.2
	4	.2	.2	.2	.1	.2	.3	.3	.2	.2	.1	.2
	5	.3	.1	.3	.1	.1	.3	.2	.2	.2	.1	.2
	Average	.2	.1	.2	.1	.2	.3	.2	.2	.2	.1	.2
4	1	.2	.1	.7	.7	.8	.7	.7	.7	.7	.7	.7
	2	.3	.2	.7	.5	.5	.7	.7	.7	.7	.5	.8
	3	.1	.0	.7	.7	.6	.7	.6	.7	.7	.6	.7
	4	.0	.0	.7	.5	.6	.6	.6	.7	.7	.6	.7
	5	.1	.0	.6	.5	.7	.6	.7	.7	.6	.6	.7
	Average	.1	.1	.7	.6	.6	.7	.7	.7	.7	.6	.7
5	1	.0	.3	.6	.7	.8	.7	.7	.8	.6	.6	.8
	2	.0	.2	.7	.6	.6	.6	.7	.7	.7	.6	.6
	3	.0	.3	.7	.7	.7	.7	.7	.7	.7	.6	.7
	4	.0	.1	.7	.8	.7	.7	.7	.7	.7	.7	1.0
	5	.0	.3	.6	.6	.7	.7	.8	.6	.6	.5	.7
	Average	.0	.2	.7	.7	.7	.7	.7	.7	.7	.6	.8
6	1	.6	.8	1.5	1.3	-----	1.8	1.9	-----	1.3	1.3	-----
	2	.7	.7	1.6	1.2	-----	1.6	1.6	-----	1.8	1.1	-----
	3	.0	.8	1.5	1.2	-----	1.5	1.5	-----	1.4	1.4	-----
	4	.4	.4	1.2	1.6	-----	1.9	2.0	-----	1.1	1.4	-----
	5	.0	.7	1.6	2.1	-----	1.7	1.3	-----	1.7	1.7	-----
	Average	.3	.7	1.5	1.5	-----	1.7	1.7	-----	1.5	1.4	-----

TABLE 5.—*Individual test results on percentage of absorption*

USING METHOD 1

Sand	Test	Laboratory no.										
		2	3	4	5	6	7	8	9	10	11	12
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	1	0.25	1.20	0.38	0.52	0.28	0.80	0.33	0.70	0.50	-----	0.15
	2	.70	1.10	.79	.80	.23	-----	.40	.70	.43	-----	Tr.
	3	1.02	-----	.55	.7	.25	-----	.37	.73	.38	-----	.21
	4	.55	.85	.82	.5	.28	-----	.25	.65	.35	-----	-----
	5	.47	.55	.24	.4	.25	-----	.32	.65	.38	-----	-----
2	1	1.97	.80	.77	.95	.50	-----	.75	1.02	.98	-----	.47
	2	.81	.65	.55	.67	.48	-----	.60	1.15	.93	-----	.53
	3	.60	.80	.38	.9	.50	-----	.62	.99	.88	-----	.75
	4	1.33	.10	.58	.7	.58	-----	.82	1.09	.95	-----	-----
	5	.60	.30	.62	1.0	.50	-----	.70	1.06	.85	-----	-----
3	1	.55	1.00	.12	.42	.25	-----	.17	.28	.40	-----	.04
	2	.53	-----	.15	.42	.20	-----	.27	.30	.23	-----	.13
	3	.47	.90	.20	.4	.28	-----	.17	.30	.20	-----	.14
	4	.75	.80	.21	.8	.28	-----	.15	.31	.15	-----	-----
	5	.47	.50	.22	.5	.35	-----	.15	.28	.25	-----	-----
4	1	.50	1.00	.00	.00	.05	-----	.22	.40	.50	-----	.14
	2	.63	.65	.00	.42	.10	-----	.25	.43	.48	-----	([1])
	3	.32	.90	.05	.00	.03	-----	.07	.40	.53	-----	([1])
	4	.20	.50	.1	.5	.10	-----	.05	.43	.60	-----	-----
	5	.35	-----	-----	.0	.08	-----	.05	.39	.48	-----	-----
5	1	.37	1.10	.23	.50	.43	-----	.30	.45	.65	-----	([1])
	2	.35	1.35	.20	.75	.38	-----	.22	.43	.63	-----	.07
	3	.32	.85	.12	.5	.33	-----	.20	.40	.55	-----	.12
	4	.25	1.15	.26	.6	.38	-----	.22	.41	.68	-----	-----
	5	.25	1.05	.12	.7	.38	-----	.22	.40	.60	-----	-----
6	1	1.49	.25	.77	.52	.25	-----	1.92	1.16	1.13	-----	-----
	2	1.46	.15	.75	.95	.38	-----	1.71	1.13	1.10	-----	.51
	3	1.68	.75	.85	.5	.58	-----	1.65	1.13	.93	-----	.74
	4	1.26	.35	.75	.7	.63	-----	2.08	1.10	1.05	-----	-----
	5	1.50	.45	.45	.9	.50	-----	1.88	1.00	.83	-----	-----

[1] Negative value obtained.

TABLE 5.—*Individual test results on percentage of absorption*—Continued

USING METHOD 2

Sand	Test	2	3	4	5	6	7	8	9	10	11	12
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	1	0.77	0.91	0.60	0.3	0.64	0.72	0.91	0.54	0.40	0.76	0.45
	2	1.10	.87	.58	.5	.66	.87	.86	.49	.23	.79	.40
	3	.77	1.02	.68	.3	.69	.68	1.02	.46	.22	.83	.43
	4	.67	1.00	.66	.4	.90	.55	.96	.46	.20	.75	-----
	5	.86	.88	.68	.5	.78	.64	.90	.54	.17	.80	-----
2	1	.87	1.69	1.48	.5	1.95	1.86	1.56	1.11	1.31	-----	1.21
	2	1.36	1.61	1.12	.6	2.41	1.90	1.50	1.13	1.24	-----	1.22
	3	1.18	1.55	1.42	.7	2.12	1.84	1.46	1.09	1.40	-----	1.18
	4	.99	1.61	1.32	.5	1.66	1.87	1.56	1.11	1.37	-----	-----
	5	.90	1.64	1.40	.4	2.25	1.74	1.56	1.19	1.20	-----	-----
3	1	.23	.25	.16	.6	.10	.10	.15	.12	.16	-----	.10
	2	.91	.27	.28	.6	.12	.10	.30	.08	.18	-----	.15
	3	.85	.24	.34	.3	.08	.10	.30	.12	.15	-----	.16
	4	.73	.22	.40	.3	.01	.10	.15	.17	.16	-----	-----
	5	.61	.27	.22	.3	.08	.10	.15	.10	.16	-----	-----
4	1	.46	.90	.62	.3	.61	.61	.45	.47	.61	-----	.54
	2	1.02	.83	.42	.2	.74	.56	.50	.44	.57	-----	.58
	3	.48	.69	.74	.5	.76	.64	.40	.40	.55	-----	.46
	4	.81	.55	.68	.5	.56	.57	.50	.42	.59	-----	-----
	5	.67	.59	.80	.5	.60	.53	.50	.40	.54	-----	-----
5	1	.48	.74	.68	.6	.89	.50	.60	.42	.49	-----	.44
	2	.87	.76	.48	.6	.84	.51	.50	.45	.53	-----	.46
	3	1.10	.62	.70	.4	.85	.57	.50	.38	.42	-----	.44
	4	.91	.65	.38	.3	.93	.56	.60	.38	.51	-----	-----
	5	.57	.69	.52	.4	.79	.56	.50	.38	.47	-----	-----
6	1	1.29	1.41	1.09	.4	.98	1.50	1.47	.95	1.43	-----	.89
	2	1.31	1.55	1.21	.4	.75	1.35	1.26	1.07	1.27	-----	.75
	3	1.59	1.41	1.10	.4	.71	1.43	1.27	1.03	1.51	-----	.81
	4	1.35	1.38	1.04	.2	1.08	1.14	1.37	.96	1.41	-----	-----
	5	1.30	1.52	1.17	.2	.90	1.19	1.27	1.11	1.35	-----	-----

USING METHOD 3

Sand	Test	2	3	4	5	6	7	8	9	10	11	12
1	1	1.38	0.92	0.77	0.6	0.90	0.72	0.84	0.78	0.45	0.78	0.72
	2	1.47	.70	.82	.7	.86	.77	.85	.79	.59	.76	.75
	3	1.90	.72	.79	.6	.90	.76	.92	.75	.58	.75	.76
	4	.59	.66	.76	1.3	.93	.80	.91	.81	.62	.78	-----
	5	.61	.81	.83	1.0	.86	.80	.88	.79	.54	.79	-----
2	1	2.05	1.62	1.64	1.3	1.60	1.57	1.72	1.54	1.10	1.58	1.43
	2	1.75	1.63	1.46	.8	1.67	1.52	1.62	1.57	1.05	1.52	1.34
	3	2.08	1.49	1.47	.8	1.57	1.66	1.59	1.55	1.27	1.56	1.47
	4	2.46	1.49	1.62	1.5	1.35	1.70	1.69	1.57	1.24	1.49	-----
	5	2.43	1.56	1.67	1.5	1.74	1.57	1.62	1.61	1.30	1.72	-----
3	1	.98	.27	.24	.3	.24	.25	.25	.18	.10	-----	.17
	2	.58	.19	.19	.5	.15	.22	.22	.22	.14	-----	.15
	3	.66	.25	.22	.5	.21	.25	.25	.23	.14	-----	.21
	4	.65	.24	.17	.6	.19	.18	.22	.18	.14	-----	-----
	5	.65	.29	.17	.6	.19	.20	.27	.22	.12	-----	-----
4	1	.69	.53	.57	.4	.59	.78	.72	.59	.58	-----	.57
	2	1.31	.62	.58	.9	.53	.76	.72	.60	.50	-----	.51
	3	.16	.44	.62	.5	.45	.70	.67	.61	.55	-----	.56
	4	.36	.62	.59	.7	.48	.76	.70	.62	.57	-----	-----
	5	.60	.59	.50	.8	.52	.66	.72	.63	.58	-----	-----
5	1	.27	.71	.77	.8	.63	.55	.80	.69	.57	-----	.75
	2	.15	.66	.75	.8	.63	.62	.75	.73	.59	-----	.77
	3	.21	.65	.66	.6	.70	.68	.75	.68	.58	-----	.80
	4	.39	.71	.66	1.1	.65	.61	.80	.70	.57	-----	-----
	5	.47	.71	.77	1.3	.60	.65	.80	.72	.55	-----	-----
6	1	1.68	1.60	1.99	1.3	1.27	1.76	2.02	1.54	1.25	-----	1.11
	2	2.20	1.75	1.68	1.1	1.42	1.57	2.04	1.98	1.16	-----	1.09
	3	2.30	1.60	1.80	1.0	1.45	1.77	1.84	1.55	1.18	-----	1.21
	4	2.25	1.75	1.55	1.8	1.22	1.97	1.94	1.41	1.10	-----	-----
	5	2.20	1.62	1.62	1.4	1.18	2.00	2.06	1.61	1.12	-----	-----

USING METHOD 4

Sand	Test	2	3	4	5	6	7	8	9	10	11	12
1	1	0.98	0.71	0.61	1.2	0.65	0.69	0.40	0.70	0.39	0.79	0.32
	2	.93	.76	.65	1.1	.66	.75	.40	.76	.37	.77	.40
	3	1.43	.89	.58	.6	.67	.60	.40	.73	.47	.81	.38
	4	.81	.77	.68	.8	.64	.56	.29	.71	.36	.73	-----
	5	.87	.68	.64	.6	.67	.30	.50	.71	.51	.74	-----
	6	-----	-----	-----	-----	-----	.56	-----	-----	-----	-----	-----
	7	-----	-----	-----	-----	-----	.50	-----	-----	-----	-----	-----
	8	-----	-----	-----	-----	-----	.58	-----	-----	-----	-----	-----
	9	-----	-----	-----	-----	-----	.50	-----	-----	-----	-----	-----
2	1	1.39	1.61	1.32	1.9	1.31	1.30	1.41	1.40	1.28	-----	1.10
	2	1.64	1.52	1.50	2.0	1.19	1.58	1.25	1.37	1.32	-----	.99
	3	1.79	1.56	1.19	.7	1.14	1.52	1.28	1.33	1.35	-----	1.05
	4	1.91	1.51	1.38	.9	1.26	1.53	1.45	1.42	1.28	-----	-----
	5	1.24	1.57	1.39	.6	1.29	-----	1.45	1.36	1.32	-----	-----
4	1	.50	.20	.22	1.1	.09	.18	.10	.22	.13	-----	.13
	2	.48	.23	.20	1.2	.08	.17	.13	.24	.10	-----	.10
	3	.63	.22	.35	.6	.18	.23	.15	.21	.11	-----	.14
	4	.26	.22	.20	.5	.15	.19	.13	.22	.14	-----	-----
	5	.25	.31	.16	.5	.12	.16	.13	.23	.11	-----	-----

TABLE 5.—*Individual test results on percentage of absorption*—Continued

USING METHOD 4—Continued

Sand	Test	Laboratory no. 2	3	4	5	6	7	8	9	10	11	12
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
4	1	0.83	0.56	0.52	1.0	0.51	0.60	0.32	0.70	0.48	-----	0.42
	2	.71	.52	.66	.9	.60	.49	.35	.67	.54	-----	.36
	3	.78	.56	.56	.4	.50	.53	.38	.67	.52	-----	.36
	4	.86	.43	.50	.4	.50	.55	.45	.65	.40	-----	-----
	5	1.02	.56	.58	.5	.51	.49	.43	.60	.50	-----	-----
5	1	1.59	.54	.57	1.3	.44	.66	.55	.75	.41	-----	.33
	2	1.07	.59	.72	1.2	.46	.58	.60	.69	.39	-----	.40
	3	1.77	.59	.50	.8	.51	.61	.58	.75	.34	-----	.40
	4	1.84	.58	.53	.5	.49	.65	.50	.77	.34	-----	-----
	5	1.43	.59	.59	.9	.48	.65	.45	.71	.40	-----	-----
6	1	1.33	1.42	1.21	1.3	1.41	1.64	1.59	1.07	1.22	-----	.50
	2	1.43	1.35	.99	1.3	1.74	1.61	1.54	1.12	1.16	-----	.57
	3	1.70	1.45	1.25	.7	1.59	1.20	1.61	1.16	1.16	-----	.59
	4	1.45	1.33	1.17	.9	1.12	1.74	1.63	1.01	1.11	-----	-----
	5	1.45	1.40	1.12	.6	1.36	1.61	1.48	-----	1.15	-----	-----

TABLE 6.—*Average values for percentage of absorption of various sands, determined by various methods in various laboratories*

Sand	Method	Laboratory 1	2	3	4	5	6	7	8	9	10	11	12	Average
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	1	0.2	0.60	0.93	0.6	0.6	0.26	0.80	0.33	0.67	0.41	0.34	0.18	0.49
	2	.7	.83	.94	.6	.4	.73	.69	.93	.50	.24	.79	.43	.65
	3	.8	1.11	.76	.8	.8	.89	.77	.88	.78	.55	.77	.74	.80
	4	.7	1.00	.76	.6	.9	.66	.56	.40	.72	.42	.77	.37	.65
2	1	.5	1.06	.53	.6	.9	.51	----	.70	1.06	.92	.66	.58	.73
	2	1.7	1.06	1.62	1.4	.5	2.08	1.84	1.53	1.13	1.30	1.62	1.20	1.42
	3	1.8	2.15	1.56	1.6	1.2	1.59	1.60	1.65	1.57	1.19	1.58	1.41	1.57
	4	1.7	1.59	1.55	1.4	1.2	1.24	1.48	1.37	1.38	1.31	1.61	1.05	1.41
3	1	.2	.55	.80	.2	.5	.27	----	.18	.29	.25	.42	.10	.34
	2	.2	.67	.25	.3	.4	.08	.10	.21	.12	.16	.21	.14	.24
	3	.2	.70	.25	.2	.5	.20	.22	.24	.21	.13	.24	.18	.27
	4	.2	.42	.24	.2	.8	.12	.19	.13	.22	.12	.23	.12	.25
4	1	.1	.40	.76	.0	.2	.07	----	.13	.41	.52	.36	.14	.28
	2	.6	.69	.71	.6	.4	.65	.58	.47	.43	.57	.61	.53	.57
	3	.7	.62	.56	.6	.7	.51	.73	.71	.61	.56	.65	.55	.62
	4	.7	.84	.53	.6	.6	.52	.53	.39	.66	.49	.63	.38	.57
5	1	.1	.31	1.10	.2	.6	.38	----	.23	.42	.62	.44	.10	.41
	2	.7	.79	.69	.6	.5	.86	.54	.54	.40	.48	.73	.45	.61
	3	.7	.30	.69	.7	.9	.64	.62	.78	.70	.57	.79	.77	.68
	4	.7	1.54	.58	.6	.9	.48	.63	.54	.73	.38	.72	.38	.68
6	1	.5	1.48	.39	.7	.7	.47	----	1.85	1.10	1.01	.79	.62	.87
	2	1.5	1.37	1.45	1.1	.3	.88	1.32	1.33	1.02	1.40	1.67	.82	1.18
	3	1.7	2.11	1.66	1.7	1.3	1.31	1.82	1.98	1.63	1.16	1.42	1.14	1.58
	4	1.4	1.47	1.39	1.2	1.0	1.44	1.56	1.57	1.09	1.16	1.48	.55	1.28

CONE METHOD FOUND TO GIVE MOST CONSISTENT RESULTS

It is possible that the extreme angularity of the stone sand was the determining factor in causing the higher value in the cone test than in the A.S.T.M. or visual inspection tests. It is also possible that there may have been some cementing of the particles by the dust present in the material. On the other hand, the dust present in the stone sand may have had such an affinity for moisture that the A.S.T.M. and visual inspection tests continued to show water present although the larger portion of the sample was only partially saturated. This would account for the lower values obtained by the use of these two methods.

In figure 3, the percentage deviation of the average result for each laboratory from the average for all laboratories is given for each method. Each value is an average for all six sands, except that the reported value for laboratory 7 for the kerosene method (no. 1) is for one sand only. These values show that the cone method (no. 3) furnished test results that were most nearly duplicated by different laboratories. Using

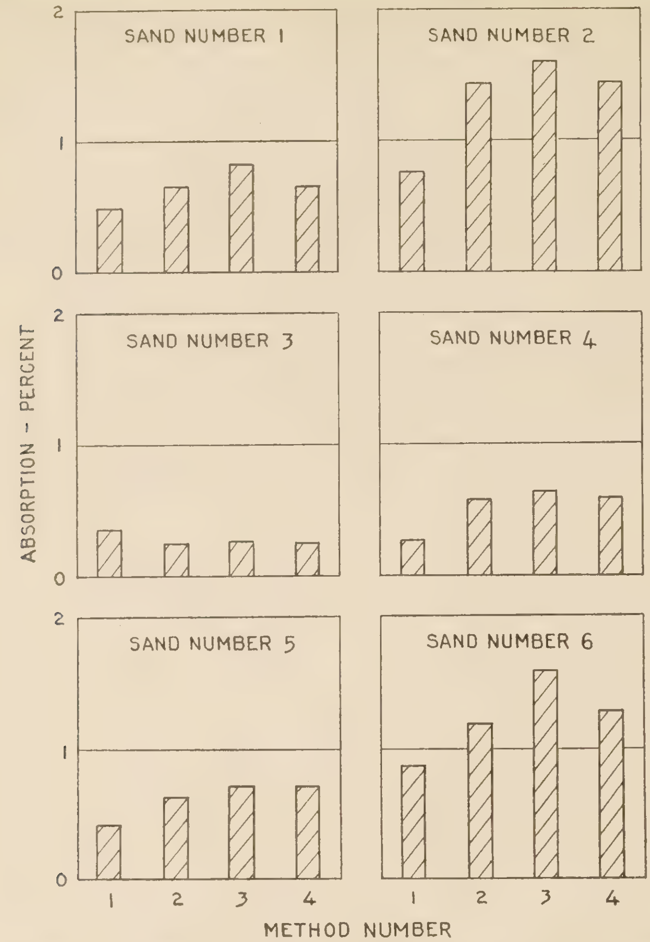

FIGURE 2.—AVERAGE RESULTS OBTAINED BY ALL LABORATORIES WITH EACH METHOD FOR DETERMINING THE ABSORPTION BY SAND.

the cone method, only 1 laboratory (no. 2) showed a marked deviation from the average, and 8 of the 12 laboratories had deviations of 15 percent or less. The average deviation for all laboratories was 17 percent.

The visual inspection method appears to be the second most accurate. Three laboratories showed wide variations from the average but six had variations of 15 percent or less. The average deviation was 24 percent. The tentative A. S. T. M. method (no. 2) gave about the same average variation (26 percent) as the visual inspection method, but only two laboratories had deviations of 15 percent or less, while seven laboratories showed deviations of 16 to 30 percent. The kerosene method was the least accurate of those under consideration. Only two laboratories showed deviations of less than 30 percent and results deviating from the average by over 50 percent were found in four laboratories. The average deviation for the kerosene method was 47 percent.

The deviations within a given laboratory as shown in figure 4 indicate that concordant results are usually obtained by the use of the tentative A. S. T. M., cone, and visual inspection methods. In most cases the kerosene method failed to furnish results agreeing with each other to a satisfactory degree.

In considering the entire series of tests, the cone method appears to be the most satisfactory means of determining the absorption by sand. It furnishes more concordant results between different laboratories than

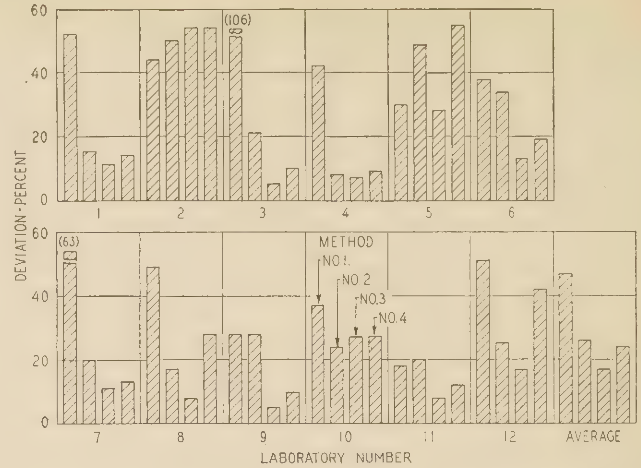

FIGURE 3.—DEVIATION OF AVERAGE RESULTS FOR EACH LABORATORY FROM AVERAGE FOR ALL LABORATORIES. VALUES ARE AVERAGES FOR ALL SANDS.

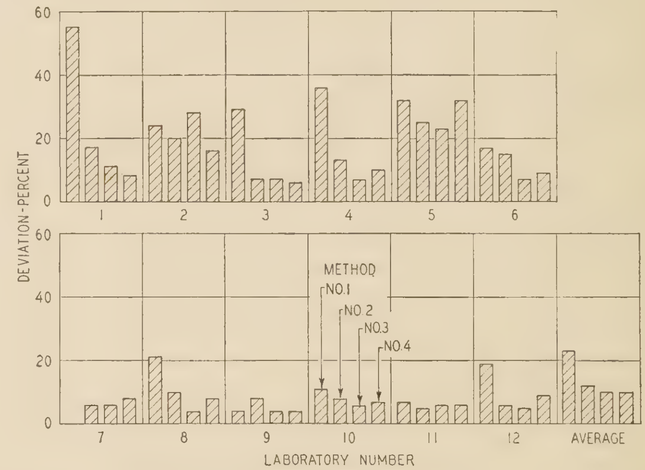

FIGURE 4.—AVERAGE DEVIATION OF INDIVIDUAL RESULTS OBTAINED IN EACH LABORATORY FROM AVERAGE RESULTS FOR THAT LABORATORY.

any of the other methods under consideration, and permits an operator to check his own work with an average variation of less than 10 percent. The average values for percentage of absorption found by this method agree very closely with those of the tentative A. S. T. M. and visual inspection methods. The tenative A. S. T. M. and visual inspection methods give very good agreement between the results of tests made by a single operator and fair agreement between the results of different laboratories. The kerosene method is found to give low and very erratic results and further use of this method is not recommended.

The cone method has been adopted by the American Association of State Highway Officials for use in their standard method of test for specific gravity and absorption of fine aggregate.[11] It has also been adopted tentatively by the Joint Committee on Methods of Test for Specific Gravity of Aggregates of Committees C–9 and D–4, A. S. T. M., for use in connection with the committees' recommendations regarding the unification of the various society methods for determining specific gravity. These recommendations are now before the two committees for consideration.

[11] Method T–84, American Association of State Highway Officials Book of Standard Specifications for Highway Materials and Methods of Sampling and Testing, 1935.

MOTOR-FUEL CONSUMPTION, 1935

[Preliminary figures, compiled for calendar year from reports of State authorities [1]]

State	Tax rate per gallon		Date of rate change	Gross amount assessed for taxation	Amount subject to refund of entire tax	Net amount on which tax was earned	Amount taxed at full rate [2]	Amount taxed at reduced rates		Approximate amount taxed for highway use [3]		Percentage change
	On Jan. 1	On Dec. 31						Rate per gallon	Amount	1935	1934	
	Cents	*Cents*		*1,000 gallons*	*1,000 gallons*	*1,000 gallons*	*1,000 gallons*	*Cents*	*1,000 gallons*	*1,000 gallons*	*1,000 gallons*	
Alabama	6	6		172, 474		172, 474	172, 474			*172, 474	*154, 977	+11. 3
Arizona	5	5		78, 359	11, 036	67, 323	67, 323			67, 323	60, 565	+11. 1
Arkansas	6½	6½		131, 784		131, 784	120, 294	(4)	11, 490	*131, 784	[5] 119, 680	(6)
California	3	3		1, 464, 458	124, 321	1, 340, 137	1, 340, 137			1, 340, 137	1, 198, 655	+11. 8
Colorado	4	4		174, 796	22, 472	152, 324	152, 324			152, 324	143, 290	+6. 3
Connecticut	2	3	Oct. 1	269, 909	6, 128	263, 781	263, 781			263, 781	248, 658	+6. 1
Delaware	3	4	July 1	45, 085	2, 137	42, 948	42, 948			42, 948	39, 514	+8. 7
Florida	7	7		256, 609		256, 609	256, 609			*256, 609	*235, 698	+8. 9
Georgia	6	6		264, 617		264, 617	264, 617			*264, 617	*239, 435	+10. 5
Idaho	5	5		70, 310	6, 352	63, 958	63, 743	2½	[7] 215	63, 743	57, 300	+11. 2
Illinois	3	3		1, 069, 242	54, 223	1, 015, 019	1, 015, 019			1, 015, 019	970, 874	+4. 5
Indiana	4	4		504. 867	32, 857	472, 010	472, 010			472, 010	438, 743	+7. 6
Iowa	3	3		421, 765	35, 276	386, 489	386, 489			386, 489	374, 998	+3. 1
Kansas	3	3		295, 308		295, 308	295, 308			295, 308	283, 876	+4. 0
Kentucky	5	5		201, 324		201, 324	201, 324			*201, 324	*184, 369	+9. 2
Louisiana	5	5		186, 201		186, 201	186, 201			*186, 201	*178, 434	+4. 4
Maine	4	4		119, 821		119, 821	114, 532	1	[8] 5, 289	114, 532	110, 924	+3. 3
Maryland	4	4		217, 665	12, 815	204, 850	203, 072	3	[9] 1, 778	204, 850	195, 663	+4. 7
Massachusetts	3	3		608, 021	23, 788	584, 233	584, 233			584, 233	566, 735	+3. 1
Michigan	3	3		809, 472	41, 485	767, 987	767, 987		(10)	767, 987	698, 681	+9. 9
Minnesota	3	3		429, 486	54, 785	374, 701	374, 701			374, 701	361, 512	+3. 6
Mississippi	6	6		140, 808		140, 808	123, 291	1	[11] 17, 517	123, 291	112, 666	+9. 4
Missouri	2	2		512, 654	14, 304	498, 350	498, 350			498, 350	478, 764	+4. 1
Montana	5	5		95, 739	18, 346	77, 393	77, 393			77, 393	73, 271	+5. 6
Nebraska	4	5	(12)	222, 584	3, 419	219, 165	219, 165			*219, 165	*214, 257	+2. 3
Nevada	4	4		26, 209	2, 163	24, 046	24, 046			24, 046	22, 355	+7. 6
New Hampshire	4	4		73, 903	1, 911	71, 992	71, 992			71, 992	68, 641	+4. 9
New Jersey	3	3		621, 031	[13] 26, 569	594, 462	594, 432	2	[14] 30	594, 432	567, 727	+4. 7
New Mexico	5	5		62, 881	4, 894	57, 987	57, 987			57, 987	51, 134	+13. 4
New York	3	4	Apr. 1	1, 537, 475	41, 612	1, 495, 863	1, 495, 863			1, 495, 863	1, 464, 242	+2. 2
North Carolina	6	6		312, 012		312, 012	305, 579	1	[11] 6, 433	305, 579	273, 686	+11. 7
North Dakota	3	3		112, 446	33, 569	78, 877	78, 877			78, 877	75, 390	+4. 6
Ohio	4	4		[15] 1, 014, 925	10, 829	1, 004, 096	965, 240	1	[15] 38, 856	965, 240	910, 214	+6. 0
Oklahoma	4	4		314, 558	[16] 14, 965	299, 593	299, 593			299, 593	270, 432	+10. 8
Oregon	5	5		183, 005	21, 812	161, 193	160, 434	1	[17] 759	160, 434	144, 917	+10. 7
Pennsylvania	3	4	July 1	1, 171, 439		1, 171, 439	1, 171, 439			*1, 171, 439	*1, 113, 629	+5. 2
Rhode Island	2	2		114, 754	8, 621	106, 133	106, 133			106, 133	102, 834	+3. 2
South Carolina	6	6		143, 014		143, 014	143, 014			*143, 014	*128, 646	+11. 2
South Dakota	4	4		112, 634		112, 634	97, 415	2	[18] 15, 219	97, 415	89, 245	+9. 2
Tennessee	7	7		216, 395	9	216, 386	216, 386			*216, 386	*201, 627	+7. 3
Texas	4	4		934, 453	98, 511	835, 942	835, 942			835, 942	791, 005	+5. 7
Utah	4	4		69, 396		69, 396	69, 396			*69, 396	*62, 858	+10. 4
Vermont	4	4		51, 388		51, 388	51, 388			*51, 388	*48, 550	+5. 8
Virginia	5	5		288, 036	15, 867	272, 169	272, 169			272, 169	249, 540	+9. 1
Washington	5	5		274, 691	22, 090	252, 601	252, 601			252, 601	239, 187	+5. 6
West Virginia	4	4		159, 120	6, 015	153, 105	153, 105			153, 105	142, 393	+7. 5
Wisconsin	4	4		442, 436	36, 527	405, 909	405, 909			405, 909	384, 981	+5. 4
Wyoming	4	4		48, 241	796	47, 445	47, 445			*47, 445	*44, 111	+7. 6
District of Columbia	2	2		112, 539	556	111, 983	111, 983			111, 983	103, 129	+8. 6
Total	Weighted average rate (approx.) 3.8 cents.			17, 160, 339	811, 060	16, 349, 279	16, 251, 693		97, 586	16, 264, 961	15, 292, 012	+6. 4

[1] A more accurate analysis of motor-fuel consumption during 1935 will be issued later. The amounts tabulated as "subject to refund" represent, for the majority of States, the amounts on which refunds were paid or allowed during the year, rather than the amounts of fuel subject to refund which were purchased or consumed during the year. The adjustments necessary in order to tabulate the amounts of such fuel actually consumed during the year have not been made on this table.

[2] In the case of States in which the tax rate changed during the year, amounts taxed at both the old and the new rate are included.

[3] 13 States do not provide for exemptions or refunds for nonhighway uses. The amounts entered for these States, indicated by stars, include both highway and nonhighway uses.

[4] Within 300 feet of border tax rate is same as that of adjacent State. Gallons taxed at 2 cents, 1,836,000; at 4 cents, 9,084,000; at 5 cents, 570,000.

[5] Estimated by State.

[6] As the 1935 figures represent both highway and nonhighway use they are not comparable with the 1934 figures. The percentage increase, based on the net amount taxed, was 4.9 percent. In obtaining the nation-wide percentage increase this slight discrepancy was neglected.

[7] Motor fuel used in aviation.

[8] 3 cents per gallon refunded on nonhighway uses.

[9] 1 cent per gallon refunded on motor fuel used in vehicles licensed to operate exclusively in cities.

[10] 1½ cents per gallon refunded on motor fuel used in interstate aviation. Amount not reported.

[11] 5 cents per gallon refunded on nonhighway uses.

[12] Tax rate 4 cents per gallon to Mar. 1, 5 cents to Sept. 20, 4 cents to Nov. 26, and 5 cents thereafter.

[13] Prior to July 1 nonhighway uses were exempted from initial payment of the tax. Beginning July 1 refunds were allowed.

[14] 1 cent per gallon refunded, prior to July 1, on motor fuel used in pleasure boats.

[15] Does not include 63,535,000 gallons of liquid fuel (kerosene, fuel oil, etc.) taxed at 1 cent per gallon but not subject to the 3-cent tax on motor-vehicle fuel.

[16] Prior to Mar. 10, agricultural uses were exempted from initial payment of the tax. Beginning Mar. 10 refunds were allowed.

[17] 4 cents per gallon refunded on motor fuel used in aviation.

[18] 2 cents per gallon refunded on nonhighway uses.

STATE MOTOR-FUEL TAX RECEIPTS, 1935

[Compiled for calendar year from reports of State authorities [1]]

State	Tax rate per gallon		Date of rate change	Receipts from taxation of motor fuel			Other receipts in connection with motor-fuel tax					Net total receipts
	On Jan. 1	On Dec. 31		Gross receipts	Refunds paid	Net receipts	Distributors' and dealers' licenses	Inspection fees [2]	Fines and penalties	Miscellaneous receipts [3]	Total	
	Cents	*Cents*										
Alabama	6	6		$10,269,346		$10,269,346	$75	$43,691			$43,766	$10,313,112
Arizona	5	5		3,833,502	$555,618	3,277,884	250		$464		714	3,278,598
Arkansas	6½	6½		8,193,647	441	8,193,206		68,118		$583	68,701	8,261,907
California	3	3		43,701,052	3,729,647	39,971,405	12,550				12,550	39,983,955
Colorado	4	4		6,814,599	805,066	6,009,533						6,009,533
Connecticut	2	3	Oct. 1	5,730,777	112,654	5,618,123	53,721				53,721	5,671,844
Delaware	3	4	July 1	1,550,441	74,009	1,476,432	2,627			2,760	5,387	1,481,819
Florida	7	7		17,865,732		17,865,732	31,240				31,240	17,896,972
Georgia	6	6		15,771,723		15,771,723						15,771,723
Idaho	5	5		3,469,195	346,451	3,122,744	415		21	1,117	1,553	3,124,297
Illinois	3	3		31,698,969	1,638,805	30,060,164		322,271	2,947		325,218	30,385,382
Indiana	4	4		20,178,070	1,314,282	18,863,788	49	398,482			398,531	19,262,319
Iowa	3	3		12,606,917	1,058,282	11,548,635	116			367	483	11,549,118
Kansas	3	3		8,830,647		8,830,647	5,215	84,533		40,795	130,543	8,961,190
Kentucky	5	5		9,835,518		9,835,518			400		400	9,835,918
Louisiana	5	5		9,345,458	15	9,345,443		[4] 71,047	479		71,526	9,416,969
Maine	4	4		4,731,244	158,678	4,572,566			230	31	261	4,572,827
Maryland	4	4		8,808,402	530,377	8,278,025						8,278,025
Massachusetts	3	3		18,056,530	722,440	17,334,090						17,334,090
Michigan	3	3		24,030,000	1,244,558	22,785,442	4,330			789	5,119	22,790,561
Minnesota	3	3		12,770,262	1,643,552	11,126,710	986	234,562			235,548	11,362,258
Mississippi	6	6		8,368,277	856,102	7,512,175	195			(5)	195	7,512,370
Missouri	2	2		10,025,641	296,233	9,729,408		105,585	10,308		115,893	9,845,301
Montana	5	5		4,740,461	895,919	3,844,542						3,844,542
Nebraska	4	5	(6)	9,860,659	148,473	9,712,186		95,514	1,034		96,548	9,808,734
Nevada	4	4		1,048,175	86,331	961,844	174		22		196	962,040
New Hampshire	4	4		2,944,615	76,449	2,868,166						2,868,166
New Jersey	3	3		18,341,548	[7] 162,088	18,179,460	25,642				25,642	18,205,102
New Mexico	5	5		3,104,009	244,713	2,859,296	18,309				18,309	2,877,605
New York	3	4	Apr. 1	57,659,473	1,407,769	56,251,704	59,541				59,541	56,311,245
North Carolina	6	6		18,745,078	385,994	18,359,084		782,457		5,474	787,931	19,147,015
North Dakota	3	3		3,329,689	1,007,078	2,322,611	776				776	2,323,387
Ohio [8]	4	4		40,760,442	1,591,656	39,168,786	365				365	39,169,151
Oklahoma	4	4		12,430,214	556,291	11,873,923			3,228		3,228	11,877,151
Oregon	5	5		9,059,398	1,120,955	7,938,443				4,410	4,410	7,942,853
Pennsylvania	3	4	July 1	40,706,631		40,706,631			13	2,196	2,209	40,708,840
Rhode Island	2	2		2,259,538	157,038	2,102,500	3,704				3,704	2,106,204
South Carolina	6	6		8,717,032	132,888	8,584,144						8,584,144
South Dakota	4	4		4,505,370	304,376	4,200,994		114,425			114,425	4,315,419
Tennessee	7	7		14,966,020	4	14,966,016						14,966,016
Texas	4	4		37,640,751	4,041,930	33,598,821				7,264	7,264	33,606,085
Utah	4	4		2,713,678		2,713,678	589		74		663	2,714,341
Vermont	4	4		2,048,561		2,048,561			84		84	2,048,645
Virginia	5	5		14,133,860	793,355	13,340,505						13,340,505
Washington	5	5		13,661,809	1,104,501	12,557,308	10,692		379		11,071	12,568,379
West Virginia	4	4		6,341,406	245,743	6,095,663	7,278				7,278	6,102,941
Wisconsin	4	4		17,509,969	1,438,762	16,071,207		178,540			178,540	16,249,747
Wyoming	4	4		1,929,650		1,929,650	2,262				2,262	1,931,912
District of Columbia	2	2		2,208,323	11,114	2,197,209						2,197,209
Total	Weighted average rate (approximately) 3.8 cents			647,852,308	31,000,637	616,851,671	241,101	2,499,225	19,683	65,786	2,825,795	619,677,466

[1] Previous tables were based on the reported earnings or assessments of the calendar year. The amounts given in this table represent actual collections of the calendar year.

[2] Inspection fees are imposed in Florida, Nevada, North Dakota, Oklahoma, South Carolina, and Tennessee, but the receipts from these fees were not reported.

[3] Includes fees for motor-fuel carrier permits, refund or exemption permits, interest on deposits, and miscellaneous unclassified receipts.

[4] Includes inspection fees on kerosene. Amount not reported.

[5] A special tax of 3 cents per gallon in Hancock County and 2 cents per gallon in Harrison and Jackson Counties is imposed for sea-wall protection. The receipts from these taxes were $133,954 in 1935. These receipts are distributed back to the respective counties.

[6] Tax rate 4 cents to Mar. 1; 5 cents to Sept. 20; 4 cents to Nov. 26; and 5 cents thereafter.

[7] Although refund law became effective on July 1, no refunds were actually paid until November. Prior to July 1 the law provided for exemptions rather than refunds for nonmotor-vehicle use.

[8] Amounts tabulated include proceeds of 1-cent tax on all liquid fuels, including kerosene and fuel oil. Gross receipts from this tax, $10,676,819; refunds, $92,266; net receipts, $10,584,553. Amount paid on nonmotor-vehicle fuels not reported separately.

STATE MOTOR-VEHICLE REGISTRATIONS, 1935

[Compiled from reports of State authorities for registration year, except as otherwise noted]

State	1935 registration period	Registered motor vehicles, private and commercial [1]					Other registered vehicles		Publicly owned vehicles, State, county, municipal [3]		1934 total registered motor vehicles	Year's change in motor-vehicle registration	
		Total motor vehicles	Passenger motor vehicles			Motor trucks, tractor trucks, etc.	Trailers and semitrailers	Motorcycles	Motor vehicles	Motorcycles		Increase or decrease	Percentage change
			Total	Automobiles (including taxicabs)	Motor busses [2]								
Alabama	Oct. 1-Sept. 30	242,676	203,687	203,376	311	38,989	5,586	694	1,118		225,732	16,944	7.5
Arizona	Jan. 1-Dec. 31	103,122	85,158	85,158		17,964	2,835	356	1,878	32	96,586	6,536	6.8
Arkansas	do	207,429	167,322	167,086	236	40,107	9,398	425	1,342	1	198,091	9,338	4.7
California	do	2,151,501	1,897,593	1,897,593	(4)	253,908	95,233	8,880	20,541	876	2,006,255	145,246	7.2
Colorado	do	284,578	256,148	256,148		28,430	968	901	(5)		274,231	10,347	3.8
Connecticut	Jan. 1-Feb. 29, 1936	375,837	313,605	312,671	934	62,232	3,092	2,021	3,189	197	354,142	21,695	6.1
Delaware	Jan. 1-Dec. 31	56,560	46,868	46,868	(4)	9,692	1,863	254	912	83	54,215	2,345	4.3
Florida	do	356,244	299,045	299,045		57,199	11,256	979	4,802	121	335,205	21,039	6.3
Georgia	Feb. 1-Jan. 31	394,096	328,017	327,645	372	66,079	10,823	952	(5)		376,993	17,103	4.5
Idaho	Jan. 1-Dec. 31	118,266	96,895	96,778	117	21,371	12,925	407	1,181	6	108,863	9,403	8.6
Illinois	do	1,525,817	1,340,340	1,340,340	(4)	185,477	14,439	4,568	7,930	723	1,456,241	69,576	4.8
Indiana	do	850,650	717,883	716,994	889	132,767	43,013	3,107	(5)		803,271	47,379	5.9
Iowa	do	699,016	618,487	618,487		80,529	[6] 50,244	1,955	[7] 4,478	53	666,440	32,576	4.9
Kansas	do	553,106	473,038	473,038	(4)	80,068	4,045	678	(5)		528,664	24,442	4.6
Kentucky	do	347,676	304,063	303,593	470	43,613	(8)	912	5,226		332,177	15,499	4.7
Louisiana	do	268,824	209,426	209,426		59,398	9,196	734	4,585	52	244,007	24,817	10.2
Maine	do	181,165	143,086	142,961	125	38,079	[9] 8,464	997	1,937	71	178,995	2,170	1.2
Maryland	do	345,578	297,050	296,148	902	48,528	1,750	1,435	[5] 2,500		332,892	12,686	3.8
Massachusetts	do	[10] 785,090	684,679	680,157	4,522	100,411	507	1,379	[11] 4,800		785,392	−302	0
Michigan	do	1,239,431	1,112,148	1,112,148	(4)	127,283	102,975	3,024	(5)		1,148,953	90,478	7.9
Minnesota	do	726,993	621,132	620,891	241	105,861	24,260	1,823	[12] 822		697,672	29,321	4.2
Mississippi	do	186,289	152,983	152,983		33,306	809	172	(5)		174,934	11,355	6.5
Missouri	do	766,369	650,550	650,141	409	115,819	22,550	1,607	2,017	8	739,813	26,556	3.6
Montana	do	149,712	114,170	114,170	(4)	35,542	2,256	380	1,587		128,336	21,376	16.7
Nebraska	do	406,189	347,135	346,859	276	59,054	20,461	998	1,855		406,632	−443	−.1
Nevada	do	34,858	27,983	27,878	105	6,875	847	109	576	9	32,230	2,628	8.2
New Hampshire [13]	Jan. 1-Mar. 31, 1936	117,154	93,699	93,699	(4)	23,455	3,173	1,082	352		113,134	4,020	3.6
New Jersey	Jan. 1-Dec. 31	888,292	763,426	758,401	5,025	124,866	4,431	4,826	9,161	674	864,641	23,651	2.7
New Mexico	do	92,457	74,212	73,837	375	18,245	889	247	978	16	82,900	9,557	11.5
New York	do	2,330,962	2,024,043	2,024,043		306,919	23,451	10,396	[7] 23,880	1,079	2,273,686	57,276	2.5
North Carolina	do	456,152	398,221	397,772	449	57,931	29,389	1,320	9,861	106	439,351	16,801	3.8
North Dakota	do	164,217	135,437	135,366	71	28,780	215	242	536		156,203	8,014	5.1
Ohio	Jan. 1-Mar. 31, 1936	1,712,051	1,541,097	1,541,097	(4)	170,954	95,216	7,095	15,406	338	1,613,265	98,786	6.1
Oklahoma	Jan. 1-Dec. 31	502,101	419,246	416,939	2,307	82,855	6,452	968	4,928		477,292	24,809	5.2
Oregon	do	[14] 293,554	250,970	250,377	593	42,584	3,558	1,393	3,971		272,102	21,452	7.9
Pennsylvania	do	1,745,401	1,516,375	1,510,837	5,538	229,026	19,732	10,115	(5)		1,681,202	64,199	3.8
Rhode Island	do	148,597	130,169	129,669	500	18,428	216	720	1,111	90	142,394	6,203	4.4
South Carolina	Nov. 1-Oct. 31	235,919	206,158	206,014	144	29,761	2,759	762	(5)		202,834	33,085	16.3
South Dakota [13]	Jan. 1-Mar. 31, 1936	179,271	152,340	152,280	60	26,931	12,568	330	1,073	10	169,975	9,296	5.5
Tennessee [13]	do	351,898	309,867	309,447	420	42,031	836	1,261	6,250		336,313	15,585	4.6
Texas	April 1-Mar 31	1,382,104	1,125,049	1,124,295	754	257,055	38,262	3,372	13,252	337	1,312,152	69,952	5.3
Utah	Jan. 1-Dec. 31	106,006	88,419	87,956	463	17,587	1,226	409	1,034	30	101,926	4,080	4.0
Vermont	Jan. 1-Mar. 31	81,513	72,482	72,380	102	[15] 9,031	1,321	575	(5)		77,921	3,592	4.6
Virginia	Apr. 1-Mar. 31	385,555	325,179	324,626	553	60,376	3,694	1,837	5,222	180	373,908	11,647	3.1
Washington	Jan. 1-Dec. 31	453,660	385,003	385,003		68,657	7,776	1,640	6,708		422,238	31,422	7.4
West Virginia [16]	July 1-June 30	241,617	212,312	211,668	644	29,305	2,189	1,007	4,280	129	223,155	18,462	8.3
Wisconsin [17]	Jan. 1-Dec. 31	754,037	623,893	623,352	541	130,144	7,610	2,554	6,915	283	709,359	44,678	6.3
Wyoming	do	69,998	55,405	55,405		14,593	7,279	195	600		64,990	5,008	7.7
Dist. of Columbia	do	171,464	153,854	152,775	1,079	17,610	1,377	675	2,002	129	163,070	8,394	5.1
Total		26,221,052	22,565,347	22,535,820	29,527	3,655,705	733,414	92,768	190,796	5,633	24,960,973	1,260,079	5.0

[1] Wherever possible, transfers and reregistrations, publicly owned vehicles, and vehicles not for highway use (farm tractors, etc.) have been eliminated from these columns.

[2] A complete segregation of motor busses from other vehicles is not available. The figures given below represent common-carrier busses in most cases, although in some States contract busses and contract school busses are included. In a number of cases city busses are not included, rural and interurban carriers only being given. Where no busses are tabulated, the busses are included with automobiles, except as noted otherwise.

[3] Previous tables have included Federal vehicles. As no figures on Federal vehicles have been made available since 1931, this information has been omitted from this table. Figures on other publicly owned vehicles are incomplete. Some States give State-owned vehicles only; others exclude certain classes, such as fire apparatus and police vehicles, from registration.

[4] Included with motor trucks.

[5] Included with private and commercial registrations.

[6] Includes 46,250 light trailers licensed without charge.

[7] Includes unknown number of Federal vehicles.

[8] Trailers of 1,000 pounds capacity or more prohibited on highways, although permitted in cities under city licenses. Tractor-semitrailers registered as trucks. Light trailers permitted but not registered.

[9] Light trailers only; heavy trailers included with motor trucks.

[10] Registration transfers, approximately 163,000 passenger and 14,000 freight, deducted.

[11] Of these vehicles, approximately 1,300 are included with private and commercial registrations.

[12] Registration required every 3 years; these are 1935 registrations only.

[13] Although registration year was extended to Mar. 31, 1936, figures tabulated are for the calendar year 1935.

[14] Registration reported as follows: Gross weight 4,000 pounds or less, 270,899; over 4,000 pounds, 25,569; bus registrations (including ambulances and hearses) 644; motorcycles, 1,393. Figures tabulated represent an approximate classification based on fully classified figures reported for 1934.

[15] Light delivery trucks included with passenger cars.

[16] Figures tabulated are for the calendar year 1935.

[17] Trucks, tractors, and trailers are registered for the period from July 1 to June 30. Figures tabulated are for the calendar year 1935.

STATE MOTOR-VEHICLE RECEIPTS, 1935

[Compiled from reports of State authorities for registration year, except as otherwise noted]

State	1935 registration period	Total receipts, registration and other fees	Motor-vehicle registration fees								Miscellaneous receipts							
			Total [1]	Passenger motor vehicles			Motor trucks, tractor trucks, etc.	Registration fees, other vehicles		Total registration fees, all vehicles	Total	Dealers' licenses and plates	Operators' and chauffeurs' permits	Certificates of title	Fines and penalties	Transfer or reregistration fees	Other miscellaneous receipts	Estimated service charges, local collectors [3]
				Total	Automobiles (including taxicabs)	Motor busses [2]		Trailers and semitrailers	Motorcycles									
Alabama	Oct. 1-Sept. 30	$3,527,781	$3,511,864							$3,511,864	$15,917	(4)			$11,177		$4,740	(4)
Arizona	Jan. 1-Dec. 31	848,146	652,827	$326,020	$326,020		$326,807	$35,917	$1,238	689,982	158,164	$3,352	$27,273	$63,226	3,262	$26,570	34,481	(5)
Arkansas	do	2,525,672	2,153,216	1,370,069	1,323,632	$46,437	783,147	204,496	923	2,358,635	167,037	17,987	115,675		4,907	6,515	21,953	
California	do	10,562,502	8,668,948	5,741,640	5,741,640	(6)	2,927,308	545,287	27,427	9,241,662	1,320,840	37,439	100,403		87,390	1,021,534	74,074	
Colorado	do	2,206,930	1,680,986	1,297,454	1,297,454		383,532	15,600	1,539	1,698,125	508,805	22,449	34,490	140,196	1,531	53,222	[7] 256,917	(5)
Connecticut	Jan. 1-Feb. 29, 1936	8,392,408	6,525,178	4,875,823	4,728,038	147,785	1,649,355	15,290	8,605	6,549,073	1,843,335	85,653	1,352,315		179,621	109,416	116,330	
Delaware	Jan. 1-Dec. 31	1,011,520	762,371	520,170	520,170	(6)	242,201	20,278	887	783,536	227,984	5,685	115,143	32,976	56,549		17,631	
Florida	do	4,954,774	4,515,227	3,228,200	3,228,200		1,287,027	127,468	5,099	4,647,794	306,980	18,599	5,610	168,952		9,092	14,717	$90,010
Georgia	Feb. 1-Jan. 31	1,248,278	1,179,347	982,023	982,023		197,324	31,494	2,850	1,213,691	34,587	5,814	13,516			6,973	8,284	
Idaho	Jan. 1-Dec. 31	1,879,602	1,727,094	1,246,194	1,226,335	19,859	480,900	22,362	2,035	1,751,491	128,111	25,890	91,775				10,446	
Illinois	do	19,075,621	17,427,427	13,090,610	13,090,610	(6)	4,336,817	120,147	16,122	17,563,696	1,511,925	86,546	268,253	416,700		463,016	277,410	
Indiana	do	8,284,904	6,464,590	4,794,247	4,715,844	78,403	1,670,343	242,552	5,678	6,712,820	1,572,084	45,406	510,450	212,132	42,088	384,296	64,543	313,169
Iowa	do	9,921,731	9,498,297	7,105,178	7,105,178		2,393,119	64,412	6,655	9,569,364	352,367	47,720	51,844		1,115	180,592	71,096	(5)
Kansas	do	3,495,576	3,306,845	2,570,920	2,570,920	(6)	735,925	47,920	3,381	3,358,146	137,430	21,557	31,995			62,880	20,998	(5)
Kentucky	do	3,507,149	3,029,761	2,029,435	1,980,520	48,915	1,000,326	(8)	2,282	3,032,043	475,106	22,836	61,119		798	131,490	2,417	256,446
Louisiana	do	3,563,380	3,167,527	2,294,139	2,294,139		873,388	313,991	3,169	3,484,687	78,693	13,365	66,404		7,136		[9] −8,212	
Maine	do	3,269,770	2,526,971	1,747,279	1,735,404	11,875	779,692	[10] 36,551	5,070	2,568,592	701,178	29,980	496,298		23,200	115,739	35,961	
Maryland	do	4,099,850	2,885,996	2,355,522	2,224,761	130,761	530,474	78,116	7,006	2,971,118	1,128,732	36,418	264,736	497,600	198,858	101,705	29,415	
Massachusetts	do	6,320,396	3,853,802	2,571,108	2,463,319	107,789	1,282,694	25,634	1,863	3,881,299	2,439,097	63,763	2,307,992				67,342	
Michigan	do	17,594,552	14,815,385	10,432,998	10,432,998	(6)	4,382,387	714,170	11,423	15,540,978	2,053,574	64,812	867,662	704,651		296,043	120,406	
Minnesota	do	7,175,323	6,790,132	5,175,253	5,071,038	104,215	1,614,879	197,809	5,744	6,993,685	181,638	37,340	117,239	296	1,530		25,233	
Mississippi	do	1,740,856	1,707,370							1,707,370	33,486	2,021			29,555		1,910	(5)
Missouri	do	8,350,511	7,368,870	6,212,828	6,212,828	(6)	1,156,042	90,645	8,319	7,467,834	882,677	68,114	167,400	369,954		248,622	28,587	
Montana [11]	do	1,271,299	1,177,696	893,360	893,360	(6)	284,336	2,256	380	1,180,332	90,967	16,225	348	31,051		34,673	8,670	
Nebraska	do	1,998,644	1,826,414	1,178,317	1,158,687	19,630	648,097	28,020	1,708	1,856,142	142,502	11,524	21,240			103,612	6,126	(5)
Nevada	do	262,464	241,793	140,217	139,692	525	101,576	7,334	473	249,600	12,864	2,531			269	8,180	1,884	(5)
New Hampshire [12]	Jan. 1-Mar. 31, 1936	1,649,660	1,197,576						4,955	1,202,531	447,129	11,670	344,154		76,679		14,626	
New Jersey	Jan. 1-Dec. 31	16,629,209	11,766,467	8,158,437	7,871,010	287,427	3,608,030	163,335	9,652	11,939,454	4,689,755	59,290	3,393,589	540,458	134,819	205,791	355,808	(5)
New Mexico	do	1,108,714	1,021,679	668,306	642,776	25,530	353,373	12,899	695	1,035,273	73,441	6,937			2,077	17,936	46,491	
New York	do	43,453,082	38,149,203	27,578,741	27,578,741		10,570,462	362,089	46,732	38,558,024	4,895,058	182,744	3,033,683		405,764	1,024,508	248,359	(5)
North Carolina	do	6,614,212	6,451,069	4,577,253	4,541,570	35,683	1,873,816	(13)	4,857	6,455,926	158,286	(4)	27,008	152,174			[9] −20,896	
North Dakota	do	1,381,482	1,305,991	980,707	971,858	8,849	325,284	3,023	1,348	1,310,362	71,120	15,001		23,300		29,783	3,036	
Ohio	Jan. 1-Mar. 31, 1936	22,153,123	20,090,909	13,263,265	13,263,265	(6)	6,827,644	784,169	28,146	20,903,224	1,249,899	119,450	192,000		38,161	589,490	32,217	278,581
Oklahoma	Jan. 1-Dec. 31	3,861,366	3,283,249	2,188,100	2,137,976	50,124	1,095,149	95,824	3,791	3,382,864	478,502	36,820		246,721			194,961	(14)
Oregon [15]	do	2,761,904	2,153,637	1,287,755	1,255,559	32,196	865,882	42,892	4,410	2,200,939	560,965	18,247	372,655	139,566			30,497	
Pennsylvania	do	32,155,367	23,667,919	16,235,424	15,692,550	542,874	7,432,495	244,397	27,980	23,940,296	8,215,071	324,970	4,776,822	1,572,086	396,092	936,305	208,796	
Rhode Island	do	2,416,154	1,921,440	1,469,348	1,422,872	46,476	452,092	1,699	2,653	1,925,792	490,362	16,200	368,448			44,183	61,531	
South Carolina	Nov. 1-Oct. 31	1,848,510	1,549,703	1,220,281	1,220,281		329,422	35,321	1,214	1,586,238	262,272	14,199	171,277		27,447	17,554	31,795	
South Dakota [12]	Jan. 1-Mar. 31, 1936	1,371,026	1,309,875	1,134,330	1,132,753	1,577	175,545	18,408	426	1,328,709	42,317	13,110		22,193			7,014	
Tennessee [12]	do	3,657,572	3,489,953							3,489,953	167,619	(4)			31,642		11,907	124,070
Texas	Apr. 1-Mar. 31	15,788,234	14,923,639	10,072,846	9,969,014	103,832	4,850,793	329,849	15,147	15,268,635	519,599	41,465	148,500			185,564	144,070	(5)
Utah	Jan. 1-Dec. 31	1,071,489	957,712	636,945	623,540	13,405	320,767	16,196	993	974,901	96,588	12,524	18,368	35,366	3,082	18,641	8,607	
Vermont	Jan. 1-Mar. 31, 1936	2,300,049	1,960,938	1,440,324	1,424,903	15,421	[16] 520,614	5,687	3,701	1,970,326	329,723	24,252	248,804			51,382	5,285	
Virginia	Apr. 1-Mar. 31	5,150,755	4,573,517	3,384,626	3,338,543	46,083	1,188,891	36,069	5,137	4,614,723	536,032	48,747	67,779	230,056		149,762	39,688	
Washington	Jan. 1-Dec. 31	3,515,175	2,598,769	1,230,177	1,230,177		1,368,592	152,311	4,690	2,755,770	759,405	9,062	507,272	117,898			9,404	115,769
West Virginia [17]	July 1-June 30	4,514,993	3,584,394	2,993,002	2,971,867	21,135	591,392	48,822	4,657	3,637,873	877,120	39,548	156,058	615,754		49,634	16,126	
Wisconsin [18]	Jan. 1-Dec. 31	10,897,032	10,497,960	7,853,484	7,598,537	254,947	2,644,476	212,864	12,807	10,723,631	173,401	25,151	25,684			174,990	[9] −52,424	
Wyoming	do	482,888	448,190	296,851	296,851		151,339	21,598	429	470,217	12,671	6,493				5,492	686	
District of Columbia	do	904,901	176,169	153,894	152,815	1,079	22,275	1,377	675	178,221	726,680	4,561	301,808	95,270	280,408	31,580	13,053	
Partial totals [19]				189,003,100	186,800,268	2,202,832	75,636,029	5,576,578	314,971									
Full totals		322,776,536	274,545,892							280,437,441	42,339,095	1,823,467	21,243,089	6,428,576	2,045,157	6,896,765	2,723,996	1,178,045

[1] No segregation of registration fees by type of vehicle was available in Alabama, Mississippi, New Hampshire, and Tennessee. In these cases the total motor-vehicle registration fees include those of trailers and motorcycles except in the case of new Hampshire. Dealers licenses in Alabama and Tennessee are also included.

[2] The figures for registration fees of busses are incomplete (see preceding table, note 2). Where no fees are tabulated, the fees of busses are included with those of automobiles, except as noted otherwise.

[3] In a large number of States service charges are collected or deducted by the county or local officers who issue registrations. In the majority of cases these charges are included in the registration and other fees as listed. In a few cases estimates were made on the basis of registration figures. In the case of Oklahoma no estimate could be made with available data.

[4] Included with registration fees.

[5] Included with registration fees and other classified receipts.

[6] Included with fees of motor trucks.

[7] Includes $253,801 in $1 assessments on motor-vehicle registrations for old-age pension fund.

[8] Trailers of 1,000 pounds capacity or more prohibited on highways, although permitted in cities under city licenses. Tractor-semitrailers registered as trucks. Light trailers permitted but not registered.

[9] Negative item due to deduction of refunds.

[10] Fees of light trailers only; fees of heavy trailers included with those of motor trucks.

[11] Registration fees are collected by counties, and State does not maintain complete record. Figures given are estimates supplied by State.

[12] Although registration year was extended to Mar. 31, 1936, figures tabulated are for the calendar year 1935.

[13] Included with fees of motor trucks.

[14] Data not sufficient for estimate.

[15] Registration fees reported as follows: Gross weight 4,000 pounds or less, $1,354,495; over 4,000 pounds, $805,909; bus registrations (including ambulances and hearses), $36,125; motorcycles, $4,410. Figures tabulated represent an approximate classification based on fully classified figures reported for 1934.

[16] Fees of light delivery trucks included with those of automobiles.

[17] Figures tabulated are for the calendar year 1935.

[18] Trucks, tractors, and trailers are registered for the period from July 1 to June 30. Figures tabulated are for the calendar year 1935.

[19] Totals of columns for which fully classified figures were not available for all States.

STATUS OF FEDERAL-AID HIGHWAY PROJECTS

1936 AND 1937 FUNDS

AS OF JULY 31, 1936

STATE	APPORTIONMENT	COMPLETED			UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
		Estimated Total Cost	Federal Aid	Miles	Estimated Total Cost	Federal Aid	Miles	Estimated Total Cost	Federal Aid	Miles	
Alabama	$ 5,208,287				$ 78,130	$ 39,065		$ 66,800	$ 33,400	9.0	$ 5,135,822
Arizona	3,564,709	$ 1,446,066	$ 1,166,429	81.1	594,942	453,504	20.4	69,864	49,688	1.7	1,895,088
Arkansas	4,275,929										4,275,929
California	9,508,671	1,065,965	609,074	35.0	7,161,950	4,075,850	152.5	2,029,553	1,169,576	55.3	3,654,171
Colorado	4,575,144	1,751,105	980,097	77.3	1,405,967	783,593	37.0	956,283	535,519	39.4	2,275,935
Connecticut	1,582,913				1,087,965	541,780	15.0				1,041,133
Delaware	1,218,750	52,544	26,272	8.8	387,204	193,602	25.6	73,078	36,539	1.9	962,337
Florida	3,315,558	518,283	259,142	17.9	574,442	287,221	18.4				2,769,195
Georgia	6,336,443	208,961	104,480	15.5	1,820,863	879,907	132.6	1,263,214	631,607	58.3	4,720,449
Idaho	3,065,304	670,814	390,698	101.4	1,553,371	927,444	88.8	914,371	547,159	92.9	1,200,003
Illinois	10,325,922	1,056,012	528,006	23.3	7,369,558	3,645,424	107.0	1,649,998	824,999	28.8	5,327,494
Indiana	6,184,258	1,828,021	912,738	67.2	3,987,634	1,993,735	132.2	406,423	203,080	8.9	3,074,705
Iowa	6,466,628	1,174,488	559,244	151.8	5,500,019	2,593,019	262.0	423,813	207,360	46.8	3,107,005
Kansas	6,631,085	1,046,298	522,833	292.5	4,022,952	1,962,918	397.8	1,991,258	992,282	281.5	3,153,052
Kentucky	4,611,955	1,529,997	761,272	98.8	677,381	323,696	44.1	1,411,418	671,428	36.2	2,855,559
Louisiana	3,557,930	616,385	308,192	23.4	1,943,614	971,807	67.4	572,566	286,283	15.7	1,991,648
Maine	2,177,197	715,690	357,047	21.4	1,119,810	559,905	36.3				1,260,245
Maryland	2,050,870							181,230	90,615	3.3	1,960,255
Massachusetts	3,485,364				607,382	303,691	5.1	273,066	136,533	3.2	3,045,140
Michigan	7,668,768	1,932,435	964,720	84.8	6,876,619	3,435,585	226.3	5,549,438	2,774,719	156.8	493,744
Minnesota	6,849,307	2,765,941	1,326,114	231.3	3,953,061	1,763,450	227.7	647,417	323,709	21.0	3,436,034
Mississippi	4,387,636										4,387,636
Missouri	7,601,200	1,809,227	903,383	295.8	4,418,472	2,209,236	123.8	3,138,984	1,569,381	198.0	2,919,200
Montana	5,122,333	2,043,492	1,144,019	216.3	2,315,689	1,296,554	202.4	236,314	94,120	10.3	2,587,639
Nebraska	5,167,930	1,111,261	555,551	75.9	1,657,754	848,239	182.6	2,164,543	1,082,271	152.5	2,681,869
Nevada	3,189,479	676,290	582,264	113.5	1,130,891	979,012	155.7	144,943	125,478	2.7	1,502,725
New Hampshire	1,218,750	259,282	126,620	7.6	489,093	241,221	14.6	168,481	84,002	2.2	766,908
New Jersey	3,352,469	87,925	43,962	1.0	2,030,222	1,015,111	28.9	1,321,388	574,164	10.4	1,719,232
New Mexico	3,990,023	1,017,857	618,877	95.1	2,163,562	1,337,949	107.8				2,033,198
New York	12,306,710	83,800	41,900	.2	11,824,789	5,846,152	205.0	1,107,240	546,000	18.8	5,872,658
North Carolina	5,879,466	722,172	361,002	107.7	2,951,390	1,474,300	333.3	697,345	335,057	71.8	3,709,107
North Dakota	3,918,269				191,740	101,206	.1				3,817,063
Ohio	9,131,204				6,286,768	3,036,015	86.6	1,616,492	663,228	8.9	5,431,961
Oklahoma	5,884,927	1,133,122	595,455	47.3	1,399,487	733,175	32.7	1,719,779	901,990	69.6	3,654,306
Oregon	4,089,711	624,112	378,566	20.6	2,727,373	1,582,189	85.3	685,192	405,177	29.0	1,723,778
Pennsylvania	10,695,448	297,941	148,702	5.0	7,301,541	3,649,735	107.8	2,249,971	1,115,230	33.2	5,781,781
Rhode Island	1,218,750										1,218,750
South Carolina	3,381,337				263,175	120,968	17.4	3,469,273	1,574,750	291.7	1,685,619
South Dakota	4,078,647	505,570	277,204	34.3	731,162	430,113	120.8	227,551	124,766	37.9	3,246,564
Tennessee	5,268,270	688,196	343,526	30.9	1,129,863	564,932	41.8	351,561	175,781	14.2	4,184,031
Texas	15,548,821	5,787,287	2,883,240	320.2	7,815,774	3,896,915	404.2	1,170,192	571,295	55.5	8,197,371
Utah	2,826,960	847,098	606,206	62.4	961,875	690,250	57.8	263,588	184,095	17.1	1,346,409
Vermont	1,218,750	300,055	149,362	14.9	899,621	449,773	44.4	400,797	173,325	7.7	446,290
Virginia	4,559,200	243,995	119,643	10.8	2,447,933	1,223,976	96.7	474,343	237,172	12.7	2,978,409
Washington	3,904,738	861,209	452,792	25.0	2,320,438	1,220,949	88.9	1,312,873	690,602	65.3	1,540,395
West Virginia	2,716,754	87,161	43,581	3.0	945,630	472,803	42.2	550,745	274,872	10.8	1,925,498
Wisconsin	6,090,504	943,634	471,640	34.0	4,209,668	2,047,548	139.2	2,075,957	923,099	90.4	2,648,217
Wyoming	3,121,972	2,045,492	1,249,184	213.0	478,644	278,990	61.6	1,078,274	663,186	209.4	930,612
District of Columbia	1,218,750				467,855	231,167	8.2				987,583
Hawaii											
TOTALS	243,750,000	40,555,183	21,873,037	3,066.0	120,283,273	61,713,674	4,786.0	45,105,616	22,603,537	2,280.8	137,559,752

CURRENT STATUS OF UNITED STATES WORKS PROGRAM HIGHWAY PROJECTS

(AS PROVIDED BY THE EMERGENCY RELIEF APPROPRIATION ACT OF 1935)

AS OF JULY 31, 1936

STATE	APPORTIONMENT	COMPLETED			UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
		Estimated Total Cost	Works Program Funds	Miles	Estimated Total Cost	Works Program Funds	Miles	Estimated Total Cost	Works Program Funds	Miles	
Alabama	$4,151,115				$3,383,581	$3,383,581	105.3	$496,537	$496,537	22.1	$270,997
Arizona	2,569,841	$973,034	$927,032	64.5	1,934,751	1,398,534	125.2	231,669	125,927	11.0	118,348
Arkansas	3,352,061	953,929	951,881	70.3	1,847,687	1,831,705	217.5	497,673	495,568	68.2	72,907
California	7,747,928	986,312	923,426	85.0	5,757,833	5,610,317	145.7	1,044,145	1,031,013	17.0	183,172
Colorado	3,395,263	795,613	795,222	60.8	1,234,958	1,234,958	36.3	51,830	51,830	1.0	1,313,253
Connecticut	1,418,709	4,268	3,995		390,994	369,280	2.2	211,807	211,337	3.2	834,097
Delaware	900,310	77,601	77,601	14.6	411,131	411,131	32.6	174,293	145,453	13.6	266,125
Florida	2,597,144	63,820	63,820	5.5	2,131,328	2,113,455	76.6	209,697	209,697	5.8	210,172
Georgia	4,988,967	143,732	143,732	6.1	653,305	653,305	47.5	321,174	321,174	17.5	3,870,755
Idaho	2,222,747	412,870	412,149	36.3	1,717,653	1,657,760	137.3	116,158	93,833	9.5	59,005
Illinois	8,694,009	1,192,096	1,191,764	59.0	6,768,340	6,768,340	363.8	639,074	639,074	44.2	94,831
Indiana	4,941,255	181,441	181,441	4.8	4,827,482	4,626,370	222.2	106,585	106,585	7.8	26,859
Iowa	4,991,664	573,511	540,850	122.1	3,067,082	2,958,918	239.3	1,001,979	967,386	82.9	524,510
Kansas	4,994,975	404,692	404,692	77.5	4,296,581	4,296,095	283.6	293,269	283,944	13.4	10,244
Kentucky	3,726,271	407,582	407,582	82.0	1,973,913	1,973,913	203.7	597,137	597,137	44.3	747,639
Louisiana	2,890,429				1,186,675	1,031,517	64.8	1,944,045	1,711,897	109.9	147,015
Maine	1,676,799	310,933	310,933	14.3	1,079,997	1,079,450	46.2	217,004	217,004	9.9	69,413
Maryland	1,750,738	21,145	21,145	1.1	328,517	328,517	12.3	1,026,583	863,243	26.3	537,833
Massachusetts	3,262,885				117,754	117,754	1.1	1,320,493	1,320,493	6.8	1,824,638
Michigan	6,301,414	992,050	992,050	55.1	5,181,621	5,121,591	229.2	53,000	53,000	3.2	134,773
Minnesota	5,277,145	1,289,579	1,142,543	261.9	3,591,608	3,115,583	448.6	1,269,692	893,227	197.4	125,792
Mississippi	3,457,552	178,812	178,104	18.3	2,762,932	2,759,505	177.5	161,912	161,912	11.8	358,031
Missouri	6,012,652	1,677,574	1,632,014	461.1	3,316,449	3,316,449	288.0	862,926	859,918	40.5	204,271
Montana	3,676,416	1,082,875	1,082,875	64.7	2,525,162	2,525,162	120.6				68,379
Nebraska	3,870,739	173,404	165,087	15.6	2,795,016	2,759,041	295.5	425,974	425,974	51.9	520,638
Nevada	2,243,074	1,080,050	1,051,050	38.9	919,016	908,447	59.8				283,577
New Hampshire	945,225	63,802	62,520	3.6	361,141	347,753	13.3	178,467	175,075	9.0	359,877
New Jersey	3,129,805				2,158,920	2,158,920	18.4	136,333	136,333	1.4	834,552
New Mexico	2,871,397	1,004,960	1,004,960	93.9	1,160,488	1,160,488	72.6	262,129	262,129	16.2	443,820
New York	11,046,377	753,983	743,037	7.8	9,957,475	9,556,620	154.1	263,000	263,000	4.7	483,719
North Carolina	4,720,173	272,901	272,901	24.4	3,135,676	3,103,087	209.5	640,970	589,887	39.4	754,298
North Dakota	2,867,245	243,587	243,587	42.6	1,036,920	1,034,711	124.1	1,287,674	1,287,674	126.6	301,272
Ohio	7,670,815	399,620	399,620	4.3	3,959,803	3,931,978	75.5	1,879,605	1,768,906	141.0	1,570,310
Oklahoma	4,580,670	347,695	347,641	37.7	2,284,571	2,281,066	195.3	1,104,077	1,103,556	134.9	848,408
Oregon	3,038,642	423,144	421,269	20.7	2,332,611	2,241,719	119.9	539,972	261,372	26.2	114,282
Pennsylvania	9,347,797	287,881	262,118	11.5	1,780,765	1,740,831	64.9	1,078,504	1,078,504	67.2	6,266,344
Rhode Island	989,208	140,528	140,528	1.6	846,817	846,817	17.4				1,863
South Carolina	2,702,012	124,976	123,773	15.5	1,677,027	1,640,431	151.6	424,798	423,537	46.2	514,272
South Dakota	2,976,454	567,178	567,178	162.8	1,546,931	1,546,931	225.1	304,954	304,954	42.9	557,391
Tennessee	4,192,460	254,922	254,922	4.4	2,240,658	2,240,658	95.8	599,051	599,051	25.9	1,097,829
Texas	11,989,350	3,550,282	3,251,462	378.9	8,606,508	7,845,757	699.4	987,870	841,609	39.6	50,523
Utah	2,067,154	530,337	519,031	46.6	1,008,648	966,358	86.1	396,884	306,128	26.7	275,636
Vermont	924,306	213,437	200,691	6.5	777,835	659,233	14.9	30,109	28,994	.4	35,387
Virginia	3,652,667	1,023,936	983,063	385.1	1,705,990	1,693,624	560.6	653,865	640,119	89.5	335,862
Washington	3,026,161	872,055	810,504	54.2	2,155,682	1,888,822	91.3	296,070	255,729	16.2	71,106
West Virginia	2,231,412				1,333,391	1,329,894	51.4	571,357	571,315	23.8	330,203
Wisconsin	4,823,884	505,796	488,739	51.1	4,727,732	4,119,668	273.8	234,329	215,477	15.9	
Wyoming	2,219,155	256,351	256,348	14.2	1,796,937	1,796,919	119.9	54,654	54,653	4.3	111,235
District of Columbia	949,496	724,656	700,626	6.0	251,210	216,234	2.5				32,636
Hawaii	926,033	93,330	80,570	1.3	549,947	541,611	7.6				303,852
TOTALS	195,000,000	26,632,280	25,736,076	2,994.2	121,595,049	117,240,808	7,427.4	25,199,328	23,451,165	1,717.7	28,571,951

CURRENT STATUS OF UNITED STATES WORKS PROGRAM GRADE CROSSING PROJECTS

(AS PROVIDED BY THE EMERGENCY RELIEF APPROPRIATION ACT OF 1935)

AS OF JULY 31, 1936

STATE	APPORTIONMENT	COMPLETED					UNDER CONSTRUCTION					APPROVED FOR CONSTRUCTION					BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
				NUMBER					NUMBER					NUMBER			
		Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	
Alabama	$ 4,034,617	$ 9,124	$ 9,124	1			$ 3,178,723	$ 3,178,723	32			$ 704,414	$ 704,414	8		11	$ 142,355
Arizona	1,256,099	47,412	47,412	1			1,002,163	986,483	10			86,220	63,832	1			158,371
Arkansas	3,574,060	396,873	394,996	12			1,505,139	1,501,881	22	5		1,655,792	1,653,103	22		29	24,081
California	7,486,362	466,411	451,116	6	3		6,946,051	6,714,198	46	4							321,048
Colorado	2,631,567	550,989	529,989	7			964,639	964,639	16								1,136,939
Connecticut	1,712,684						78,774	78,774		1		79,677	79,677	1			1,554,233
Delaware	418,239						143,486	120,000	1								298,239
Florida	2,827,883	15,489	15,489		1		1,741,112	1,738,801	17	4		340,039	340,039	8			733,554
Georgia	4,895,949						276,256	276,256	5	1		230,061	230,061	6			4,389,632
Idaho	1,674,479	93,565	93,565	1			936,692	936,692	17	1		96,366	90,000	1			554,222
Illinois	10,307,184	84,015	84,015	4			5,160,753	5,160,753	44	2		2,589,904	2,589,904	12	1		2,472,512
Indiana	5,111,096						4,499,732	4,377,088	36	7		824,914	501,186	2	3	161	232,822
Iowa	5,600,679	26,763	25,500	1	2		3,417,483	3,312,197	67	6		1,657,471	1,648,868	27	2	6	614,113
Kansas	5,246,258						4,518,794	4,518,794	42	1		727,464	727,464	11		3	
Kentucky	3,672,387	15,290	15,290	1			2,443,349	2,153,617	18			264,339	264,339	4	3		1,239,142
Louisiana	3,213,467						814,208	814,208	7	1		1,608,180	1,560,001	14	3		839,259
Maine	1,426,861	60,837	60,504	1			574,409	573,818	12			297,093	297,093	5		1	495,447
Maryland	2,061,751						414,161	414,161	3	2		967,014	944,545	3	2	11	703,045
Massachusetts	4,210,833						1,591,534	1,591,534	12	2		334,460	334,460	4			2,284,839
Michigan	6,765,197	489,625	489,625	5	1		5,646,177	5,601,677	37	6							673,895
Minnesota	5,395,441	353,423	353,423	14		8	3,046,507	3,040,457	52	8	5	723,774	723,774	13	1	28	1,277,787
Mississippi	3,241,475						1,953,738	1,953,738	42	3		286,260	286,260	5		1	1,001,477
Missouri	6,142,153						4,362,626	4,349,324	31	1		1,534,151	1,525,769	13		2	267,060
Montana	2,722,327	574,892	574,892	9	2		2,019,089	2,019,089	27	4							128,345
Nebraska	3,556,441	199,361	199,361	4			1,946,376	1,946,376	65	1	1	1,280,515	1,280,515	10	1	22	130,189
Nevada	887,260	306,096	306,096	7			379,746	379,746	3								201,418
New Hampshire	822,484						354,902	354,902	3	3	1						467,582
New Jersey	3,983,826						1,159,350	1,159,350	6	2		542,110	542,110	6			2,282,366
New Mexico	1,725,286	272,505	272,505	6			693,593	693,593	5	1		647,939	637,866	6			121,323
New York	13,577,189	19,640	19,640		1		9,699,184	9,438,638	32	30		636,050	635,770		5		3,483,141
North Carolina	4,823,958	94,809	94,809	1	2		1,649,075	1,649,075	21	8		905,934	889,535	12	4		2,190,538
North Dakota	3,207,473	39,335	39,335	1			1,347,422	1,346,422	24			667,297	667,297	14	1		1,154,420
Ohio	8,439,897						1,867,025	1,774,786	11	1		2,160,847	2,038,598	17	2		4,626,513
Oklahoma	5,004,711	402,404	402,404	8	1		1,675,196	1,675,196	26	1		1,402,699	1,402,699	20	1		1,524,412
Oregon	2,334,204	36,709	36,709	1			1,987,879	1,863,168	12	6		434,327	434,327	4		2	
Pennsylvania	11,483,613	10,836	10,836	3			3,792,062	3,586,259	30	9		2,678,263	2,264,598	23	5		5,621,921
Rhode Island	699,691						654,008	654,008	4	1							45,683
South Carolina	3,059,956						1,368,967	1,358,001	27	5	2	571,285	570,875	11		29	1,131,080
South Dakota	3,249,086	77,597	77,597	4			829,820	829,820	20			769,273	769,273	17	1	6	1,572,397
Tennessee	3,903,979	21,428	21,428	1			534,900	534,900	11	1	2	441,257	441,257	10	1	16	2,906,393
Texas	10,855,982	312,659	312,659	10			7,357,872	7,351,673	85	12		2,982,735	2,929,520	28	3	149	262,129
Utah	1,230,763	29,757	29,757		1		608,107	608,107	9			165,398	140,000	2			452,899
Vermont	729,857	164,678	164,678	3	3		297,333	295,975	4	2		76,786	74,992	2		10	194,212
Virginia	3,774,287	172,632	172,632	11			1,383,605	1,312,742	22	2		675,769	634,609	18	2	9	1,654,304
Washington	3,095,041	230,418	230,418	3	2		1,767,038	1,762,207	12	6	1	639,941	639,941	5	3	6	462,474
West Virginia	2,677,937						438,108	438,108	3	1		455,602	455,602	4			1,784,227
Wisconsin	5,022,683	211,231	211,231	3			2,594,410	2,594,410	25	5		1,320,424	1,320,424	5	1		896,618
Wyoming	1,360,841	55,366	55,365	2			325,013	325,011	3			627,191	587,664	4			392,801
Dist. of Columbia	410,804						423,907	409,259	3								1,545
Hawaii	453,703						296,218	295,333	3			215,430	158,369	2			1
TOTALS	196,000,000	5,842,169	5,802,400	131	19	8	102,666,711	101,013,967	1065	156	12	35,304,665	34,080,630	380	45	502	55,103,003

PUBLICATIONS of the BUREAU OF PUBLIC ROADS

Any of the following publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. As his office is not connected with the Department and as the Department does not sell publications, please send no remittance to the United States Department of Agriculture.

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An Economic and Statistical Analysis of Highway-Construction Expenditures. 15 cents.

Single copies of the following publications may be obtained from the Bureau of Public Roads upon request. They cannot be purchased from the Superintendent of Documents.

SEPARATE REPRINT FROM THE YEARBOOK

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TRANSPORTATION SURVEY REPORTS

Report of a Survey of Transportation on the State Highway System of Ohio (1927).

Report of a Survey of Transportation on the State Highways of Vermont (1927).

Report of a Survey of Transportation on the State Highways of New Hampshire (1927).

Report of a Plan of Highway Improvement in the Regional Area of Cleveland, Ohio (1928).

Report of a Survey of Transportation on the State Highways of Pennsylvania (1928).

Report of a Survey of Traffic on the Federal-Aid Highway Systems of Eleven Western States (1930).

A complete list of the publications of the Bureau of Public Roads, classified according to subject and including the more important articles in PUBLIC ROADS, may be obtained upon request addressed to the U. S. Bureau of Public Roads, Willard Building, Washington, D. C.

CURRENT STATUS OF UNITED STATES PUBLIC WORKS ROAD CONSTRUCTION

AS PROVIDED BY SECTION 204 OF THE NATIONAL INDUSTRIAL RECOVERY ACT (1934 FUNDS) AND BY THE ACT OF JUNE 18, 1934 (1935 FUNDS)

AS OF JULY 31, 1936

STATE	APPORTIONMENTS		COMPLETED				UNDER CONSTRUCTION				APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS	
	Sec. 204 of the Act of June 16, 1933 (1934 Fund)	Act of June 18, 1934 (1935 Fund)	Total Cost	1934 Public Works Funds	1935 Public Works Funds	Mileage	Estimated Total Cost	1934 Public Works Funds	1935 Public Works Funds	Mileage	1934 Public Works Funds	1935 Public Works Funds	Mileage	1934 Public Works Funds	1935 Public Works Funds
Alabama	$ 8,370,133	$ 4,259,842	$ 14,723,002	$ 8,203,670	$ 3,103,535	739.3	$ 806,311	$ 160,296	$ 646,015	35.2		$ 453,670	2.9	$ 6,167	$ 56,622
Arizona	5,211,960	2,641,935	8,989,074	5,204,513	2,579,530	543.0	12,500		12,500					7,447	49,905
Arkansas	6,748,335	3,428,049	10,902,752	6,636,112	3,296,968	618.0	62,020		61,965	1.1	$ 9,241	49,945	1.4	102,981	19,172
California	15,607,354	7,932,206	29,429,219	15,589,249	7,584,383	759.6	1,293,183		290,015	.9		820		18,105	56,988
Colorado	6,874,530	3,486,006	11,177,865	6,831,431	3,441,857	636.3								43,099	44,149
Connecticut	2,865,740	1,454,868	4,061,019	2,789,088	859,239	69.3	482,548		453,705	4.8	40,533			36,119	141,924
Delaware	1,819,088	923,395	2,676,358	1,818,804	815,188	128.3	56,002		56,002	.5		52,205	1.1	284	
Florida	5,231,834	2,661,343	8,656,787	5,175,534	2,114,489	296.7	468,781		437,733	12.2		15,955	.8	56,300	93,165
Georgia	10,091,185	5,113,491	12,168,863	9,026,532	2,480,466	694.3	1,957,935	569,377	1,340,534	115.4	218,756	85,519	18.0	276,520	1,206,971
Idaho	4,486,249	2,277,486	6,615,368	4,416,568	1,787,381	496.8	429,790		425,402	4.7	42,905	37,043		26,776	27,659
Illinois	17,570,770	8,921,401	23,808,620	16,387,551	6,603,392	649.3	3,303,516	1,040,808	2,156,062	52.8	44,638	19,740	14.7	97,774	142,207
Indiana	10,037,843	5,088,963	14,449,277	9,777,926	4,025,907	443.8	1,166,876	203,943	896,582	44.7		134,587	.4	55,974	31,887
Iowa	10,055,660	5,118,361	15,333,141	10,055,660	4,681,121	1,215.5	412,102		389,800	8.5		47,440	3.3		
Kansas	10,089,604	5,117,675	15,313,097	9,971,849	5,005,778	1,120.9	210,397	68,553	106,757	14.4	9,000	5,140	.9	40,201	
Kentucky	7,517,359	3,818,311	11,092,789	7,087,455	3,196,455	793.6	776,141	411,849	331,140	16.8	-7,838	176,365	2.7	10,217	114,352
Louisiana	5,828,591	2,963,932	8,704,663	5,616,786	2,466,942	236.1	401,032	138,621	248,948	17.1	56,549	72,999	6.4	16,635	175,043
Maine	3,369,917	1,711,586	5,222,823	3,337,541	1,657,506	193.1	7,234		7,234		10,573			21,803	46,846
Maryland	3,564,527	1,810,058	4,850,828	3,150,380	714,205	128.2	846,904	331,728	463,462	28.4		183,983	3.4	82,420	448,407
Massachusetts	6,597,100	3,350,474	7,467,342	4,582,227	2,241,385	112.4	2,713,189	1,896,850	816,339	2.9		114,280	.3	118,022	178,471
Michigan	12,736,227	6,452,568	19,737,477	12,696,114	5,517,976	728.8	872,325		814,348	39.5		28,925		40,113	91,320
Minnesota	10,656,569	5,425,551	16,078,567	10,495,068	4,713,102	1,633.2	395,722	16,282	333,564	13.2		64,328	3.6	145,218	314,558
Mississippi	6,978,675	3,540,227	11,867,417	6,584,009	2,402,426	678.1	1,463,103	336,141	1,057,996	65.9	4,437	34,895	.9	54,088	44,909
Missouri	12,180,306	6,173,740	16,791,927	11,154,098	4,577,390	1,431.8	2,681,061	937,703	1,485,324	19.5		108,538	.4	88,505	2,488
Montana	7,439,748	3,769,734	11,378,085	7,324,443	3,380,520	1,029.9	460,934	64,459	323,489	28.4				50,846	65,725
Nebraska	7,828,961	3,964,364	12,547,646	7,709,817	3,572,168	1,006.2	536,363	70,773	273,550	37.1		98,740	8.7	48,371	19,905
Nevada	4,545,917	2,302,356	6,771,659	4,499,583	1,989,191	741.9	272,217		272,217	12.1	23,736	5,250	6.5	22,598	35,698
New Hampshire	1,909,839	969,462	2,973,832	1,904,951	937,585	77.7						6,482		4,888	25,396
New Jersey	6,346,039	3,220,879	7,756,836	6,126,421	1,126,624	81.5	1,784,114		1,585,161	5.8	107,208	303,276	8.4	112,410	205,818
New Mexico	5,792,935	2,941,700	8,654,309	5,625,342	2,805,137	762.8	50,695		33,710	2.3				167,593	102,853
New York	22,330,101	11,327,921	38,031,567	21,548,282	9,845,914	802.1	2,547,170	616,884	1,279,899	21.1	20,947	151,620	.2	143,988	50,488
North Carolina	9,522,293	4,840,941	14,541,762	9,036,263	4,283,185	1,329.1	473,671	212,961	260,710	20.9	100,071	205,439	5.6	172,997	91,607
North Dakota	5,804,448	2,938,967	7,760,885	5,578,194	1,491,544	2,030.0	851,765	74,977	723,779	98.8	26,322	195,253	16.7	124,955	528,390
Ohio	15,484,592	7,865,012	23,778,287	15,301,982	6,679,773	770.3	1,117,240	95,950	1,003,640	24.3	27,376	52,706	1.7	59,285	128,893
Oklahoma	9,216,798	4,685,180	14,099,927	9,133,731	3,993,691	804.0	490,905	67,007	422,163	2.1		6,250	.4	16,060	263,076
Oregon	6,106,896	3,097,814	9,532,136	5,968,059	2,659,661	462.4	466,132	64,950	305,644	6.4		25,041		73,888	107,468
Pennsylvania	18,891,004	9,590,788	27,745,680	18,147,273	8,262,022	1,011.3	1,303,427	456,292	753,541	47.2	34,552	276,282	3.2	252,887	298,943
Rhode Island	1,998,708	1,014,572	3,148,010	1,998,708	1,014,572	89.1									
South Carolina	5,459,165	2,770,954	7,336,705	5,217,183	1,876,355	589.0	785,787	121,449	641,929	35.9	11,408	96,684	2.9	109,125	155,985
South Dakota	6,011,479	3,047,643	8,751,168	5,718,722	2,458,767	1,511.6	585,788	89,443	496,345	31.5	18,974	6,687	16.7	184,341	85,844
Tennessee	8,492,619	4,302,991	12,678,279	8,368,445	3,406,825	475.8	953,882	124,174	733,910	16.9		19,868	.1		142,389
Texas	24,244,024	12,291,253	37,334,470	23,829,962	11,648,828	2,774.2	952,895	325,282	532,648	11.9		500	7.1	88,780	109,277
Utah	4,194,708	2,132,691	7,123,928	4,162,416	1,943,960	586.5	202,180		156,741	4,4	32,292	31,762			228
Vermont	1,867,573	948,007	3,032,919	1,863,531	837,747	137.6	123,085	3,922	93,611	2.7		5,299	.7	121	11,350
Virginia	7,416,757	3,765,387	11,445,708	7,232,702	3,266,198	587.6	221,840	17,720	202,770	27.8	56,178	24,235	2.9	110,157	272,184
Washington	6,115,867	3,106,412	9,244,404	6,098,252	2,907,420	302.4	121,628		115,530	.3	13,790	46,596		3,825	36,866
West Virginia	4,474,234	2,280,335	5,872,312	4,321,372	1,289,459	196.1	942,272	84,032	801,733	25.9		89,815	1.2	68,830	99,329
Wisconsin	9,724,881	4,941,837	15,253,645	9,676,693	4,781,158	619.2	129,060	7,300	79,318	.5		41,376		40,888	39,985
Wyoming	4,501,327	2,287,712	6,843,611	4,468,896	2,165,179	1,035.9	47,579	11,728	30,962	1.8		28,905		20,702	62,666
District of Columbia	1,918,469	973,842	2,747,515	1,909,584	837,795	20.8	120,199		84,699	1.5				8,885	51,348
Hawaii	1,871,062	949,778	2,602,372	1,870,383	180,263	50.6	740,023		736,463	5.2		23,433		679	9,619
TOTALS	394,000,000	200,000,000	599,105,932	381,229,355	165,508,162	34,232.0	37,099,523	8,621,454	24,775,589	971.3	917,324	3,427,876	144.2	3,231,867	6,288,373

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